December Specifications Committee Meeting Agenda

Meeting Date

Wednesday, December 5, 2018 @ 9:00am
Building 5, Room 855

Approved Permanent Specification changes from last Committee meeting (10/3/18)
- **636.1-Description, 636.2-Materials, 636.4-Aggregates and Dust Palliatives, 636.23-Method of Measurement, 636.24-Basis of Payment, & 636.25-Pay Items** The update removes reference to Bituminous Material & Calcium Chloride for Dust Palliative. It also changes Shadow Vehicle units from Day to Month.
- **615.3.2.1-Weathering Steel Bridges** Updates ASTM requirements
- **207.9-Subgrade** Allows RAP material in subgrade
- **715.11-Engineering Fabric** updates AASHTO M 288 references
- **716.2-Test Methods & 716.3.2.3-Material** Upgrades testing requirements

Approved Project Specific Special Provisions (SP) from last Committee meeting (10/3/18)
- **SP103 - Alternative Design and Alternative Bidding (ADAB)**

Items removed from Committee Agenda
- None

Old Business - Provisions discussed at last Committee meeting

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>604</td>
<td>Section 604 - Pipe Culverts</td>
<td>6th time to Committee; discussed in February, April, June, August and October. Proposed specification change to Section 604. It is a complete Section rewrite. The specification has been updated (joints). It is redline copy, showing only proposed changes from the last meeting. Approval is expected in December</td>
</tr>
<tr>
<td>708</td>
<td>708.5 through 708.9</td>
<td>1. 708.5 through 708.9 The subsections have been updated. Approval of 708.5-708.9 expected in December</td>
</tr>
<tr>
<td>713</td>
<td>Section 713 - Metal Pipe</td>
<td>2. Section 713 Metal Pipe The subsections have been updated. Approval of Section 713 expected in December</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td>Time to Committee; Discussed in</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>714</td>
<td>Concrete and Plastic Pipe</td>
<td>February, April, June, August, and October.</td>
</tr>
<tr>
<td>606</td>
<td>Description, Materials, &amp; Pay Items</td>
<td>June, August, and October.</td>
</tr>
<tr>
<td>655</td>
<td>Tied Concrete Block Erosion Matting</td>
<td>June, August, and October.</td>
</tr>
<tr>
<td>420</td>
<td>Single/Multiple Course Micro Surfacing</td>
<td>June, August, and October.</td>
</tr>
<tr>
<td>716</td>
<td>General, Granular Material</td>
<td>June, August, and October.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>
| 695 | SP695 - Mainline Pavement | 4th time to committee; discussed in June, August, and October. This is an update to an previously approved SP.  
Project Specific Special Provision that allows Contactor to select either asphalt pavement system or concrete pavement system.  
Provision has been updated per comments at the last meeting. A redline copy, showing the latest changes/updates is included.  
Approval expected in December |
| 320 | SP320 - Aggregate Course and Speed Control Mounds of Truck Escape Ramp | 3rd time to committee; discussed in August & October. This is an update to an previously approved SP.  
Update to Project Specific Special Provision for Aggregate Course and Speed Control Mounds of Truck Escape Ramp. It updates the aggregate requirements and is redline copy showing the proposed changes.  
Provision has been updated per comments at the last meeting. A redline copy, showing the latest changes/updates is included.  
Approval expected in December |
| 207 | 207.2.2.2-Gradation  
212 | 212.5.2-Gradation  
307 | 307.2.4.1.2-Gradation  
604 | 604.2.4.2-Gradation  
609 | 609.2.5.1-Gradation | 3rd time to committee; discussed in August & October.  
Proposed specification change to various section's Gradation subsection. The update clarifies the testing and sublots.  
207.2.2.2 & 212.5.2 are redline copies showing the proposed changes to the existing specification.  
307.2.4.1.2, 604.2.4.2, and 609.2.5.1 show only the proposed language.  
No update to the provision.  
Approval expected in December |
| 401 | 401.5.1-Procedures, 401.6.4-Compaction, 401.7.3-Compaction, & 401.13-Basis of Payment | 3rd time to committee; discussed in August & October.  
Proposed specification change to Section 401. It revises the compaction requirements.  
The asphalt subcommittee discussed this proposed specification during their September meeting.  
There are two versions of the proposed specification included: one is redline copy showing the proposed changes to the existing specification and the other is the proposed specification.  
Approval expected in December |
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>3rd time to committee; discussed in August &amp; October.</th>
<th>Proposed specification change to Section 607-Guardrail. It allows use of Zinc-Aluminum-Magnesium Alloy Coated Steel Deep Beam Type Guardrail. No update to the provision. Approval expected in December</th>
</tr>
</thead>
<tbody>
<tr>
<td>712</td>
<td>712.5-Zinc-Aluminum-Magnesium Alloy Coated Steel Deep Beam Type Guardrail Removed and Rebuilt or Stored</td>
<td>The material requirements changes/updates related to the guardrail revision are also included: 1. 712.5-Zinc-Aluminum-Magnesium Alloy Coated Steel Deep Beam Type Guardrail Approval of Section 712.5 expected in December</td>
<td></td>
</tr>
<tr>
<td>688</td>
<td>SP688-Water Jetting</td>
<td>3rd time to committee; discussed in August &amp; October.</td>
<td>Project Specific Special Provision for Section 688 - Field Painting of Metal Structures. The SP would allow surface preparation only via Ultrahigh-Pressure (UHP) Water Jetting option. Provision has been updated per comments at the last meeting, as SSPC-SC 12 has been withdrawn. Reference to SP WJ-1 has been added. Approval expected in December</td>
</tr>
<tr>
<td>105</td>
<td>105.6.1-Division Owned Utilities</td>
<td>2nd time to committee; discussed in October. Previously approved Project Specific Special Provision (SP). Proposed specification change for locating Division owned utilities on projects. The SP has been added to all proposals since May 2016. Proposed specification has been updated per comments at the last meeting. Approval expected in December</td>
<td></td>
</tr>
<tr>
<td>601</td>
<td>601.13.3-Concrete Protective Coating</td>
<td>2nd time to committee; discussed in October.</td>
<td>Proposed specification change to Section 601. It updates the concrete protective coating subsection. Proposed specification has been updated per comments at the last meeting. Approval of 601.13.3 expected in December</td>
</tr>
<tr>
<td>711</td>
<td>711.1 through 711.22</td>
<td>The material requirements changes/updates related to the coatings are also included. 1. 711.1 through 711.22 Approval of 711.1-711.22 expected in December</td>
<td></td>
</tr>
<tr>
<td>640</td>
<td>640.4.5-Minimal Field Office</td>
<td>2nd time to committee; discussed in October.</td>
<td>Proposed specification change to Section 640. It removes the copier requirements from the minimal field office. A redline copy, showing the proposed changes/updates to the existing specification is included. No update to the specification. Approval expected in December</td>
</tr>
</tbody>
</table>
Section 657 - Roadside Sign Supports

2nd time to committee; discussed in October.
Proposed specification change to Section 657. It is a complete Section re-write.
The update is to bring the specification to current AASHTO standards and in line with the revision to the Standard Details.
The material requirements changes/updates related to the Roadside Sign Supports are also included. The Division 700 proposed specifications are below:
1. 709.51-Surface Mount Sign Support Breakaway Devices
2. 709.52-Steel Beam Sign Support Omni-directional Breakaway
3. 709.53-Square Tube Sign Support
4. 709.54-Back to Back U-Channel Sign Support Breakaway
5. 709.55-Type A and B Barrier Wall Sign Support Brackets

No update to the provision.
Approval Section 657 and 709.51-709.55 expected in December

Section 658 - Overhead Sign Structures

2nd time to committee; discussed in October.
Proposed specification change to Section 658. It updates the 658.1, 658.2, 658.5, and 658.8 subsections.
The update is to bring the specification to current AASHTO standards and in line with the revision to the Standard Details.

No update to the provision.
Approval expected in December

Section 661 - Traffic Signs and Delineators

2nd time to committee; discussed in October.
Proposed specification change to Section 661. It is a complete Section re-write.
The update is to bring the specification to current AASHTO standards and in line with the revision to the Standard Details.
The material requirements changes/updates related to the Traffic Signs and Delineators are also included. The Division 700 proposed specifications are below:
1. 715.9.3-Channelizing Devices
2. 715.9.4-Reflective Sign Support Strip

No update to the provision.
Approval of Section 661, 715.9.3, and 715.9.4 expected in December

Section 664 - Traffic Safety Devices

2nd time to committee; discussed in October.
Proposed specification change to Section 664. It updates 664.2 & 664.3.
The update is to bring the specification to MASH implementation requirements.
The material requirements changes/updates related to the Traffic Signs and Delineators are also included. The Division 700 proposed specifications are below:
1. 715.41-Traffic Safety Devices

12-5-18 Agenda Page 5
No update to the provision.
Approval Section 664 and 715.41 expected in December

720  Section 720 - Smoothness Testing  
2nd time to committee; discussed in October. 
Proposed specification change to Section 720. 
A redline copy, showing the proposed changes/updates to the existing specification is included. 
Proposed specification has been updated per comments at the last meeting. Approval expected in December

707  707.15.2 - Performance Requirements for Concrete Hydration Control Stabilizing Admixtures 
2nd time to committee; discussed in October. 
Proposed specification change to Section 707. It updates 707.15.2 and outlines the approval process for the 3-hour discharge time extended mixes. 
A redline copy, showing the proposed changes/updates to the specification is included. 
No update to the specification. Approval expected in December

New Business - New Provisions for Spec Committee

<table>
<thead>
<tr>
<th>SECTION</th>
<th>TITLE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>SP 105 - Dates of Governing Specifications and Standard Details</td>
<td>This is an update to previously approved SP's. 1st time to Committee. Project Specific provision to provide overriding dates for the Standard Specifications and Standard Details Book, Volume I and II. The special provision would be added to the project proposal and will alleviate need for the designer updating plan notes when these manuals are updated. The provision is a redline copy, showing the changes/updates to the special provision.</td>
</tr>
<tr>
<td>601</td>
<td>601.4.2-Contractor's Quality Control</td>
<td>1st time to committee. Proposed specification change to Section 601. It updates the contractor’s quality control subsection. It requires direct oversight of concrete batching operations by certified PCC Technician. It also requires any Agency tests Contractor QC cylinders to be certified for testing cylinders in accordance with ASTM C1077. A redline copy, showing the proposed changes/updates to the existing specification is included.</td>
</tr>
<tr>
<td>601</td>
<td>601.7-Mixing</td>
<td>1st time to committee. Proposed specification change to Section 601. It clarifies the 1-hour discharge time doesn’t apply when mixes that use a hydration control stabilizing admixture are used. It also notes that if superplasticizer is used to adjust the slump of a mix at the jobsite, water can’t be used after that to make further slump adjustments.</td>
</tr>
</tbody>
</table>
601 601.8.7 - Removal of Forms and Construction of Superimposed Elements  
1st time to committee. 
Proposed specification change to Section 601. It requires adjacent bridge deck placements within a pour sequence to be treated as superimposed elements in Table 601.8.7.

603 SP 603 - Post Tensioning  
1st time to committee. 
Project Specific Special Provision (SP) for furnishing, installing, stressing, and grouting of post tensioning tendons.

604 SP 604 - Cured-in-Place Pipe Liner  
1st time to committee. 
Project Specific Special Provision (SP) for cured-In-Place pipe liner.

Comments
Comments are requested on these Specification Changes and Project Specific Special Provisions. Please share your comments by December 3, 2019, they help in the decision making process.

Please Send Comments to: DOHSpecializations@wv.gov

Deadline for new items & updates to these provisions is January 5, 2019
If you are the 'champion' of any specification changes and/or project specific special provisions currently in the Specification Committee, it is your responsibility to edit/update/modify them in a timely manner per comments and discussion in Spec Committee. Failure to submit updates may result in removal of item and/or delays.

Next Meeting
Wednesday, February 6, 2019 at 9am
Building 5, Room 855: (If Available. If not available a change in venue will be attached on the door)

2017 Standard Specifications Roads and Bridges & 2018 Supplemental Specifications
Electronic Copy (pdf): The 2017 Standard Specifications Roads and Bridges & 2018 Supplemental Specifications can be viewed, printed, or downloaded from the Specifications Website. A link to the Specifications pages is here:
http://transportation.wv.gov/highways/contractadmin/specifications

Print Version: Hard copies of the 2017 Standard Specifications Roads and Bridges & 2018 Supplemental Specifications are available thru Contract Administration. An order form for the book is on Specifications Website. A link to the pages is here:
http://transportation.wv.gov/highways/contractadmin/specifications

2019 Supplemental Specifications
2019 Supplemental will go into effect on all project lettings after 1/1/19. It will be posted on specifications webpage in mid-December. Hard copy will be available in early 2019.

2019 Specifications Committee
The Specification Committee typically meet every other month; on the first Wednesday. 2019 meetings will be held in February, April, June, August, October, and December.
Calendar subject to change, updates will be given, as needed.

Specifications Committee Website
A copy of the meeting agenda can be found on the Specifications Committee Website
http://transportation.wv.gov/highways/contractadmin/specifications/SpecComit

Material Procedures
Material Procedures (MPs) referenced in provisions are available upon request.

For questions regarding the Standard Specifications Roads and Bridges, Supplemental Specifications, Project Specific Special Provisions, or the Specifications Committee please e-mail DOHSpecifications@wv.gov

File Format Structure and Progression of items thru Specifications Committee
The purpose of the below protocol is to provide guidance on the file structure of Proposed Specification & Project Specific Special Provision as they progress thru Specification Committee. This procedure would facilitate a means of tracking changes from meeting to meeting; as the agendas & provisions are posted publicly online on the Spec Committee website.

TYPES OF PROVISIONS:
There are three standard types of provisions typically discussed in committee:
1. Specification Changes – These are permanent changes to the WVDOT Standard Specifications.
   ○ Unless inserted into a project proposal, these changes typically go into effect in January (of subsequent year) with the Supplemental Specifications.
2. Project Specific Special Provisions (SP) – Are applied to specifically designated projects.
3. Updates to previously approved SP – Changes/edits/updated to SP that have been approved by spec committee.

NEW BUSINESS ITEMS:
New items to should be setup & submitted in the following format:
1. Specification Changes – Shown as red-line copy (see note)
2. Project Specific Special Provisions (SP) – Will be shown in all black.
3. Updates to approved SP – Shown as red-line copy

Each item should also include a description with:
• Brief overview of item
• Background info and/or reason for change

NOTE: Red-line copy is a form of editing in which indicate removal or addition of text. You can redline a Microsoft Word document by using the built in “Track Changes” feature or you can manually redline document with font color changes & strike-through.

OLD BUSINESS ITEMS:
Updated provisions that were discussed at the last committee meeting should be setup in the following format:
• Redline copy from prior meeting would not be shown
• Redline copy of new changes/updates (from previous meeting)

PROGRESSION OF ITEMS THRU COMMITTEE AND APPROVAL:
Depending on how important the project and/or comments/discussion of item at previous meeting, then several things can happen in no particular order

- Few comments/discussion/minor changes ... will recommend approval of item at next meeting
- A lot of comments/discussion ... will not recommend approval at next meeting; item will be updated and reviewed again at next meeting.
- SP’s in committee may be used in advertised project. Hope to work to address comments & finish approving at subsequent meeting.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 604
PIPE CULVERTS

604.1-DESCRIPTION:
This work shall consist of the construction or reconstruction of pipe culverts, in accordance with these Specifications and in reasonably close conformity with the lines, grades, dimensions, and locations shown on the plans or established by the Engineer.

604.2-MATERIALS:
Materials shall conform to the following requirements of Division 700, except as otherwise noted:

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>SUBSECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Structural Plate Box Culvert</td>
<td>713.18</td>
</tr>
<tr>
<td>Aluminum Coated Corrugated Steel Pipe and Pipe Arch</td>
<td>713.24</td>
</tr>
<tr>
<td>Bitumen Sealant</td>
<td>708.9</td>
</tr>
<tr>
<td>Controlled Low Strength Material (CLSM)</td>
<td>219</td>
</tr>
<tr>
<td>Concrete End Section for Arch, Elliptical, or Round Concrete Pipe</td>
<td>714.8</td>
</tr>
<tr>
<td>Crushed Aggregate</td>
<td>704.6, Class 1 or Class 3</td>
</tr>
<tr>
<td>End Section for Corrugated Steel Pipe, Safety Slope, or Pipe Arch</td>
<td>713.20</td>
</tr>
<tr>
<td>Flexible Watertight Gaskets for Circular Concrete Pipe</td>
<td>708.7</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>702.1.2-702.1.5 and 702.6, or 702.2</td>
</tr>
<tr>
<td>Granular Material</td>
<td>716.1.1.2</td>
</tr>
<tr>
<td>High Density Polyethylene Pipe (HDPE), Profile Wall</td>
<td>714.19</td>
</tr>
<tr>
<td>High Density Polyethylene Pipe (HDPE), Steel-Reinforced</td>
<td>714.26</td>
</tr>
<tr>
<td>Polypropylene Pipe</td>
<td>714.24</td>
</tr>
<tr>
<td>Polyvinyl Chloride (PVC) Pipe</td>
<td>714.22</td>
</tr>
<tr>
<td>Precast Reinforced Concrete Box Culverts</td>
<td>714.7</td>
</tr>
<tr>
<td>Reinforced Concrete Elliptical Pipe</td>
<td>714.4</td>
</tr>
<tr>
<td>Reinforced Concrete Pipe</td>
<td>714.2</td>
</tr>
<tr>
<td>Reinforced Concrete Pipe Arch</td>
<td>714.3</td>
</tr>
<tr>
<td>Safety Slope End Sections</td>
<td>713.20</td>
</tr>
</tbody>
</table>
When the locations of manufacturing plants allow, the plants may be inspected periodically for compliance with specified manufacturing methods, and material samples may be obtained for laboratory testing for compliance with material quality requirements. This may be the basis for quality acceptance of manufactured lots.

All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

All references to "corrugated steel pipe" are considered applicable to the paving classes (paved invert, full paved, etc.) for which the base metal conforms to AASHTO M 218 or AASHTO M 274.

The sheet thickness for corrugated steel pipe shall be as designated on the Plans.

604.2.1-Quality Control Testing: Quality control of the granular material and crushed aggregate is the responsibility of the Contractor as specified in 106.1.

The Contractor shall maintain necessary equipment and qualified personnel to perform all sampling and testing necessary to determine the magnitude of the various properties of the material governed by the Specifications and shall maintain these properties within the limits of the Specifications.

The Contractor shall submit a quality control plan detailing the methods by which the quality control program will be conducted. This plan, prepared in accordance with the guidelines set forth in the appropriate portions of MP 307.00.50 and MP 717.04.21, shall be submitted to the Engineer at the preconstruction conference. The work shall not begin until the plan is reviewed for conformance with the contract documents.

604.2.2-Acceptance Testing: Quality control sampling and testing performed by the Contractor may be used by the Division for Acceptance.

604.2.3-Sampling and Testing: Frequency of sampling and testing shall be in accordance with the contractor’s quality control plan. The minimum sampling and testing frequencies for gradation shall be as indicated in Attachment 1 of MP 307.00.50. The material shall be sampled in accordance with MP 700.00.06. The minimum sampling and testing frequency for compaction will be in accordance with MP 717.04.21.

604.2.4-Acceptance Plan:

604.2.4.1-Compaction: Compaction of backfill material shall meet 604.8.

604.2.4.2-Gradation: Acceptance for gradation shall be on the basis of test results on consecutive random samples from a lot. A lot shall be considered the quantity of material represented by an average test value, not to exceed five sublots. Generally, at the beginning of the project, the average shall be started on the second sample in accordance with MP 300.00.51. A sublot is the quantity of material represented by a single gradation test. In the case where only one sample is taken, this sublot shall be considered the lot. When the average, or when the most recent three consecutive individual test values fall outside the limits specified in Table 704.6.2A, the lot of material represented will be considered nonconforming to the extent that the last of its sublots is nonconforming. When this occurs,
the last sublot shall have its price adjusted in accordance with Table 604.14.1. In the case
where the average is nonconforming and the last sublot contained is conforming, then there
would be no price adjustment. In no event, however, shall a sublot of material have its
price adjusted more than once, and the first adjustment, which is determined, shall apply.

604.2.4.3-Degree of Nonconformance: When a sublot of material is to have its price
adjusted, the percentage point difference between the nonconforming test value and the
specification limit shall be determined for each sieve size determined to be nonconforming,
and this value shall be multiplied by its appropriate multiplication factor as set forth in
Table 604.2.4.3

<table>
<thead>
<tr>
<th>Nonconforming Sieve Size</th>
<th>Multiplication Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ½ in. (37.5 mm)</td>
<td>1.0</td>
</tr>
<tr>
<td>¾ in. (19 mm)</td>
<td>1.0</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>1.0</td>
</tr>
<tr>
<td>No. 40 (425 µm)</td>
<td>1.0</td>
</tr>
<tr>
<td>No. 200 (75µm)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

The total measure of nonconformance of an individual sublot is the sum of all
nonconformance of an individual sieve sizes of that sublot.

When the total degree of nonconformance has been established and it is 12.0 or less,
the material will be for at an adjusted contract price as specified in Table 604.14.1.

When the degree of nonconformance is greater than 12.0, the nonconforming sublot
shall be resolved on an individual basis, requiring a special investigation by the Engineer
to determine the appropriate course of action to be followed.

CONSTRUCTION METHODS

604.3-GENERAL:
Subject to the provisions prescribed, the flow line of a pipe culvert may be altered from
that shown on the plans.
Galvanized steel pipe or bands shall not come in contact with aluminized steel pipe or
bands.
The diameter of pipe, as used in this Section, is the largest dimension, horizontal or vertical.

604.4-TRENCH EXCAVATION:
604.4.1-Pipe Culverts 18 Inches (450 mm) Through 96 Inches (2400 mm): In complete
or partial fill sections, before trenching is begun, the fill shall be constructed for a minimum
distance of six diameters on each side of the pipe and to a height of 2 feet (600 mm) over the
top of the pipe or to the surface of the completed embankment if less than 2 feet (600 mm)
above the top of the pipe.
The minimum width of the trench, in either cut of fill sections, shall be calculated using
the formulas below. The Contractor shall increase these minimums to a width that allows the
jointing of the pipe, and adequate placement and compaction of the backfill.
Pipe Culverts of 36 inches (615 mm) diameter or less:
  = Outside Diameter + 18 Inches (450mm) on each side of the pipe

Pipe Culverts with diameter greater than 36 inches (615 mm)
  = Outside Diameter + 24 Inches (600 mm) on each side of the pipe

604.4.1.1-Pipe Culverts Installed Using Controlled Low Strength Material (Type F Trench): When using a controlled low strength material (CLSM) the width of the trench shall not be less than the Outside Diameter plus 6 inches on each side of the pipe.

604.4.2-Pipe Greater Than 96 Inches (2400 mm): In complete or partial fill sections, before trenching is begun, the fill shall be constructed for a distance of six diameters on each side of the pipe and to a minimum height of 25 percent of the vertical dimension of the pipe.

Installation of the pipe shall be as detailed in the plans, including the type and amount of backfill and bedding.

The Contractor shall submit shop drawings detailing all erection procedures including anticipated movements during backfilling operations. Backfill operations shall also be detailed to show lift thicknesses, sequence of lifts and shape of the culvert during these operations.

The Contractor shall submit a plan of field control for the installation insuring the pipe is erected in accordance with the shop and erection drawings.

604.4.3-Structural Plate Box Culvert: Excavation for the foundations of structural plate box culvert shall be in accordance with 212.3.

604.4.4-Precast Concrete Box Culvert: The minimum width of the trench shall be 18 inches on each side of the box culvert.

604.5-BEDDING:

Unless otherwise noted in the plans, bedding shall conform to the following requirements. Rigid pipe bedding shall be granular material or crushed aggregate with a 3 inch (75 mm) minimum thickness. Flexible pipe bedding shall be crushed aggregate with a 4 inch (100 mm) minimum thickness. The bedding material placed under the middle 1/3 of the pipe diameter shall be loosely placed and uncompacted to allow for cradling of the pipe bottom. Bedding outside of the middle 1/3 shall be compacted.

When rock or unyielding material is present in the trench bottom, 6 inches of granular material shall be installed below the bottom of the pipe or box culvert.

Box culvert bedding shall be granular material or crushed rock-fine aggregate with a 4-inch (100 mm) minimum thickness.

604.6-LAYING AND JOINING:

604.6.1-Rigid and Flexible Pipe and Concrete Box Culvert: The pipe/culvert placing, unless the Contractor is otherwise directed, shall begin at the downstream end of the pipe/culvert. The lower segment of the pipe/culvert shall be in contact with the bedding throughout its full length. Bell or groove ends of pipes and outside circumferential laps of corrugated steel pipe shall be placed facing upstream.
Paved or partially lined culverts shall be laid so that the longitudinal centerline of the paved segment coincides with the flow line.

Rigid pipes/culverts may be of either bell and spigot or tongue and groove design, unless one type is specified. The method of joining pipe sections shall be such that the ends are fully entered, and the inner surfaces are reasonably flush and even. Joints for rigid pipes/culverts shall be made with flexible watertight gaskets that conform to ASTM C443 or bitumen sealant combined with an external sealing wrap which conforms to ASTM 877, Type III, or by a combination of these types; they. All joints shall be installed to form a leak resistant seal.

Flexible pipes/culverts shall be joined by couplings in accordance with manufacturer’s recommendations—bell and spigot joints, and the pipe shall be fastened—installed to preserve the alignment, provide a leak resistant joint that conforms to ASTM D3212 performance requirements, and prevent the separation of sections.

Pipe culverts shall be inspected before any backfill is placed. Any pipe found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced.

**604.6.2-Structural Plate Box Culvert:** Plate box culvert shall be set on footings as shown on the Plans. Beginning at the upstream end, the first side plates shall be set on the base angles. Then the remaining side plates and the top plates shall be bolted into place using only enough bolts to hold them without tightening securely. Drift pins may be used to assist in matching bolt holes. Temporary props may be used to hold plates in place until connections are made. After the plates comprising the first set have been assembled, the next set shall be placed in the same manner, finishing each set of side plates with a top plate before placing in the same manner, finishing each set of side plates with a top plate before placing the next set of side plates. New plates shall be lapped one corrugation on the outside of the preceding plates. When all the plates are in position, the remaining bolts shall be inserted and all nuts firmly tightened. Steel bolts shall be torqued during installation to a minimum of 100 ft-lbs. (135 Newton meters), and a maximum of 300 ft-lbs. (400 Newton meters), Aluminum bolts shall be torqued during installation to a minimum of 100 ft-lbs., (135 Newton meters), and a maximum of 150 ft-lbs. (200 Newton meters). For power driven tools, the hold-on period may vary from 2 to 5 seconds. Bolts shall be of sufficient length to provide for a full nut.

**604.7-Blank**

**604.8-BACKFILLING:**

The use of a bulldozer or other bladed equipment in placing backfill is expressly forbidden. Mechanical equipment with various type buckets may be used. All pipe, after being bedded and backfilled, shall be protected by a 4 feet (1200 mm) cover of fill, or more if necessary, before heavy equipment is permitted to cross during the construction of the roadway. The Contractor will be held responsible for any damage to the pipe resulting from movement of equipment over the structure.

**604.8.1-Initial Backfill Zone:** Rigid Pipe initial backfill material shall be suitable granular material free from particles larger than 1-½ inch (40mm), crushed aggregate, or controlled low strength material. For flexible pipe, the initial backfill material shall be crushed aggregate backfill or controlled low strength material. The initial backfill material shall be placed along the pipe in layers not to exceed 4 inches (100 mm) and compacted to 95% standard proctor; to
a minimum of the spring line for rigid pipe and to a minimum height of 6 inches (150 mm) over the top of flexible pipe. Controlled low strength material shall be placed according to Section 219; and any type of CLSM may be used. Unless otherwise specified in the plans, CLSM can be used as a substitute for granular material or crushed aggregate at the contractor’s option.

Care shall be taken to compact the material under the haunches of the pipe, to place the backfill evenly on each side of the pipe to retain its vertical axis, and to avoid displacement. The backfill and compaction efforts shall be advanced simultaneously on both sides of the pipe.

Box culvert initial backfill material shall be suitable granular material free from particle sizes larger than 1-1/2 inch (40 mm) or crushed aggregate. Unless otherwise noted on the plans, it shall be placed to a minimum of 12 inches (300 mm) over the top of box culvert.

**604.8.2-Final Backfill Zone:** Unless otherwise noted in the plans, the area above initial backfill zone shall be suitable random material free from particles larger than 1 inch (25mm), crushed aggregate, or controlled low strength material. This method of backfilling and compacting shall be followed until the top of the trench is reached.

**604.8.3-Backfill Testing:** The quality control testing and acceptance of CLSM shall be according to 219.

The quality control testing and acceptance for compaction of the random backfill material shall be in accordance with applicable sections of 207 and 716, granular material according to 716, and crushed aggregate according to 717, with the following exception:

Testing will be conducted on both sides of the pipe and testing within a lot may include tests on both sides of the pipe. For pipe installations in an embankment where existing tests are on file for the adjacent embankment material, the target percentage of dry density for the pipe backfill will be equal to the average of the X values for the tests in the adjacent lots of embankment material or a minimum value of 95, whichever is greater. For embankments where no tests are on file, the target percentage of dry density will be 95. A lot shall have five (5) density tests performed for quality control.

For pipes less than 60 inches (1500 mm) in diameter, a lot will normally consist of the quantity of backfill required for each 75 linear feet (23 m) of pipe installed.

For pipes 60 inches (1500 mm) in diameter and larger, a lot will normally consist of not more than 5 lifts of backfill. For pipe with lifts of backfill placed for the full length of the pipe, a sublot will normally consist of a lift of backfill placed on both sides for the full length of the pipe. For pipes that are backfilled in segments, a sublot will normally consist of a lift of backfill placed on both sides for the length of each segment of pipe backfilled.

Backfill placed outside embankments and roadbed is to be compacted to or better than the average total dry density for the existing soil. An average total dry density will be determined from representative density tests conducted for each existing soil. Quality control testing will normally consist of one test per 100 linear feet (30 m) of pipe installed, and lot evaluations are not required. The moisture tolerance is not applicable.

**604.9-FIELD PAVING:**

The Contractor may pave with Portland cement concrete or use shotcrete. If practicable, such paving shall be delayed until completion of the fill over the structure. Before the placing of
the paving, the surface of the plates shall be cleaned. The Portland cement concrete or shotcrete, mesh reinforcement, fastening of mesh, and paving dimensions shall be as specified and the minimum thickness over the crest of the corrugations shall be 1-1/2 inches (40 mm).

Concrete used shall have a design 28-day compressive strength of 3,000 psi (21 MPa) (equivalent to Class B in 601.3); concrete may be hand mixed and shall be handled and placed as directed by the Engineer. After initial set has taken place, the paving shall be flooded or kept moist by sprinkling for three days. Liquid membrane-forming compound, conforming to 707.9 may be used for curing at a minimum application rate of one gallon per 150 square feet (0.25 liters per m²) of concrete surface. Other methods of curing may be used if approved by the Engineer.

Field paving with shotcrete shall conform to the applicable provisions of 623. When paving with shotcrete, the exposed surface shall be brought to a uniform surface by screeding or troweling. After completion of the shotcrete paving, the rebound material shall be cleaned from the culvert above the paved surface. Shotcrete shall be cured by (a) covering with burlap mats and keeping them wet for at least seven days after placing, (b) flooding for a period of at least seven days or, (c) applying liquid membrane curing compound, conforming to 707.9, at a minimum rate of one gallon per 150 per feet (0.25 liters per m²) of shotcrete surface for each application. Shotcrete cured by membrane forming compound shall receive two applications; the second application shall be made after the first application has set. Other methods of curing may be used if approved by the Engineer.

After the completion of the fill over the pipe, any gaps which develop between the plates and the concrete or shotcrete paving shall be filled by pouring heated asphalt material complying with requirements of 713.3.

Prior to using Portland cement concrete or shotcrete for paving culverts with coatings containing aluminum, the aluminum-concrete contact area shall be coated with commercially-available paint.

604.10-REMOVE AND RELAY PIPE:

When specified, the Contractor shall remove, salvage, clean, safely store, and relay existing culverts. The construction requirements in this Section shall apply equally in the case of remove and relay pipe. The Contractor shall restore or replace, any pipe designated for reuse that incurs damage or destruction through faulty handling or storage. All pipes salvaged for relaying shall be cleaned of all foreign material prior to reinstallation.

604.11-JACKING PIPE:

Jacking or tunneling may be designated on the Plans or may be permitted if written approval is obtained. Culverts to be jacked shall be reinforced concrete pipe. The strength of pipe designated in the Contract will be designated as required for vertical load only. Additional reinforcement or strength of pipe required to withstand jacking pressure shall be determined and furnished by the Contractor without additional cost to the Division. Variation from theoretical alignment and grade at the time of completion of jacking placement shall not exceed 0.2 feet for each 20 feet (10 mm per m) of pipe so placed.

An approach trench shall be constructed on the side from which jacking operations shall take place. The end of the approach trench away from the jacking face shall be cut perpendicular to the axis of the jacking operation to provide bearing surface for the back stop and the jack blocking. The length of the approach trench shall be such that the distance between the jack blocking and the face of the bore shall be equal to 5 feet (1500 mm) plus the length of the individual
Pipe sections. The jacking face shall be a minimum of 3 feet (1 m) above the top of the pipe; the face shall be cut vertically and shall be shored to prevent raveling and slipping. A sump shall be constructed in one corner of the trench to provide drainage. The back stop shall be constructed of heavy timbers or steel rails capable of withstanding the jacking force.

In the event the site of jacking operations is such that an approach trench cannot be constructed, the jack blocking shall be constructed to carry the reaction of the jack to the ground. This may be accomplished by means of timber, steel, or concrete vertical back stops set into the ground with the tops supported by diagonal members bearing against an embedded anchorage.

Directly opposite the approach trench, an exit trench shall be constructed to line and grade. The exit trench shall be constructed in the same manner as the approach trench except that no back wall is necessary.

Jacks shall be of sufficient capacity to overcome soil resistance to the jacking operation and shall be operated in pairs. As a guide, capacity of jacks for concrete pipe shall be a minimum of 50 tons (45 Mg) each. For large pipe, more than one pair of jacks may be required. Small track jacks may be used to start the pipe.

Pipe guides shall be constructed in the approach trench and may be either timber or steel rail or concrete guides on a cradle. Since the pipe guides will support the pipe as it enters the jacking face, the pipe guides shall be accurately set to line and grade, and excavation for the guides shall be made to grade to avoid occurrence of settlement. Guides shall be spaced, as required.

Reaction of the jack to the pipe shall be transmitted by either a jacking frame or jacking beams constructed of timber or steel. Jacking frames and beams shall be so placed as to exert equal pressure on each side of the pipe. For pipes 36 inches (900 mm) in diameter or smaller, a steel jacking ring may be used in lieu of the jacking frame.

The pressure from the jacking frame or beams may be transmitted to a jacking collar or head on the pipe itself. Jacking collars or heads for concrete pipe shall be constructed to prevent damage to the pipe ends. Jacking collars and jacking frames shall be constructed to allow passage of men and material.

Joints of concrete pipe shall be cushioned and protected from infiltration of fine materials occurring during the jacking operation by insertion of a plywood or OSB of 1/2”-3/4” thickness cushioning material into each pipe joint. After the pipe is in position, the joints shall be pointed from the inside with mortar joint compound. The use of a jacking shield is permitted.

To prevent the pipe from "freezing" and becoming incapable of movement, jacking operations should, if possible, be carried out on a 24-hour basis. Alignment and grade of the pipe guides shall be checked at least once each shift. To aid in the prevention of "freezing," the pipe shall be lubricated in a manner and with a material meeting the approval of the Engineer.

Excavation for the bore shall be to grade at the bottom and approximately 1 inch (25 mm) greater than the diameter of the pipe at the top and sides. As excavation proceeds, the jacking shall proceed until the effective limit of the jacking is reached, at which time additional blocking shall be added. This process shall be continued until there is room for an additional pipe section. For long runs of pipe, the use of intermediate jacking stations will be allowed as approved by the Engineer.

Pipe cover shall be a minimum of one diameter or 3 feet (900 mm) from top of pipe to bottom of the subgrade of ballast when jacking under a highway.

After the pipe has been jacked into place, the annular area between the pipe wall and the remaining soil shall be pressure grouted to remove any chance of settling. The backfill shall be tightly compacted around both ends of the culvert to prevent erosion. Any departure from the
above specifications necessitated due to site conditions shall be approved in writing by the Engineer.

Areas resulting from caving or excavation outside the above limits shall be backfilled with grout, or by a method which will fill the voids. Joints shall be completed as specified for the type of pipe being installed.

604.12-INSPECTION AND ACCEPTANCE:

In addition to the inspection performed by the Department during the initial installation of pipe culverts, a post installation inspection will be conducted before final acceptance. No sooner than 30 days following installation, the Engineer will visually inspect all culverts. Pipes larger than 42” diameter will be manually inspected for excessive deflection of flexible pipe and excessive cracking in rigid pipe, and joint issues for all pipes.

Any excessive cracks, differential movement, spalls, exposed reinforcement, slabbing, dents, buckling, holes, damaged coating, obstructions, improperly engaged joints, improper gasket placement, excessive joint gaps, misaligned joints, excessive deflection, or undue horizontal or vertical misalignment will be cause for repair or replacement at no cost to the Division. Efflorescence and rust stains should be evaluated to determine if detrimental or just a cosmetic defect.

604.12.1-Rigid Pipe Criteria: Concrete pipe cracks equal to or less than one hundredth of an inch (0.01) are considered hairline and minor. Cracks greater than one hundredth of an inch (0.01) but less than five hundredths of an inch (0.05), shall be sealed by the method proposed by the manufacturer and approved by the Engineer. Concrete pipe with cracks with width equal to or greater than five hundredths of an inch (0.05) and less than one tenth (0.1) shall be evaluated by the Engineer for repair or replacement. Concrete pipe with cracks one tenth (0.1) inch or greater in width shall be replaced by the Contractor to the satisfaction of the Engineer.

604.12.2-Flexible Pipe Criteria: Flexible pipe deflection equal to or less than 5 percent of the original diameter will not require remediation. Deflections of 5 percent up to 7.4 percent of the original diameter will be evaluated by the Engineer for repair or replacement. If flexible pipe is deflected 7.5 percent of the original diameter, the pipe shall be replaced by the Contractor to the satisfaction of the Engineer.

Plastic pipe with cracks exceeding 1/8-inch width by 6-inches long shall be evaluated by the Engineer for structural and hydraulic integrity.

604.12.3-Testing of Pipe: A post installation camera/video inspection of pipe culverts and laser/mandrel deflection inspection of flexible pipe shall be conducted by the Contractor on all pipe culverts that meet the following requirements:

1. Cumulative total of 250 linear feet (75 m) or more of pipe culverts on project
2. Project located on NHS routes

The Contractor may visually inspect, in the presence of the Engineer, in lieu of camera/video inspection where pipe culverts size, orientation, and location allow for easy visual examination.

The Contractor shall provide a digital copy of the camera/video inspection and issue a report in digital format, detailing all issues or deficiencies noted during the inspection,
including a remediation plan for each deficiency, no later than 7 days after completion of the inspection

604.13-METHOD OF MEASUREMENT:

Pipe of the different types and sizes, both new and re-laid, will be measured by the linear foot (m) in place, the measurement being made along the centerline of each pipe installed. Branch connections, tees, wyes, and elbows will be measured along their centerlines and these lengths included in the total lengths of the pipe. Wyes, tees, and other branch connections will be measured along the centerlines to points of intersection. Pipe with sloped or skewed ends will be measured along the invert. The portion of pipe extending through to the inside face of headwalls of all types, manholes, inlets, boxes, or other structures shall be included in the measurement.

End sections will be measured by the number of units installed.

Pipe designated on the Plans to be installed by the jacking method will be measured separately by the linear foot (m) in place and shall be the actual portion jacked, completed in place, and accepted.

604.14-BASIS OF PAYMENT:

The quantities, determined as provided above, will be paid for at the contract unit prices bid for the items listed in 604.15, which prices and payments shall be full compensation for excavation and bedding, except as otherwise provided, backfilling, jacking when called for, furnishing all materials and doing all the work prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, supplies, and incidentals necessary to complete the work. The unit price bid for end sections shall include excavation and backfill.

When, by the authority of the Engineer, the flow line of a pipe is lowered from that shown on Plans, or due to a lack of a firm foundation, or due to a solid rock foundation, unsatisfactory material is removed and replaced with suitable material, the work of excavation, replacement, and compaction of material will be paid for in accordance with 109.4.

1. For pipe culverts less than 48-inches (1200 mm) diameter, the work of excavation, measured in excess of 1 foot (300 mm) below the original planned pipe elevation, will be paid for under the provisions of 109.4. When suitable material is not available from the project excavation, payment for replacement material below final grade line will be made in accordance with 109.4.

2. For pipe culverts 48-inches (1200 mm) diameter or larger, all additional excavation below the original planned pipe elevation and for a width not in excess of the outside pipe diameter plus 18 inches (450 mm) on each side of the pipe, will be paid for at the unit bid price for Item 207001-* "Unclassified Excavation". When no Item 207001-* is included in the Proposal, payment for excavation, backfill compaction and replacement material will be made in accordance with 109.4. When suitable material is not available from the project excavation, replacement material will be paid for in accordance with 109.4.

604.14.1-Price Adjustment: Crushed aggregate not conforming with the gradation requirements as described in 604.2.4.2 will be paid for at the adjusted contract price base on the degree of nonconformance as specified in Table 604.14.1.

A revised unit price for calculation purposes in 307.9.1 will be established based on the unit bid cost minus the cost of the pipe.
TABLE 604.14.1
Adjustment of Contract Price for Gradation not Within Specifications

<table>
<thead>
<tr>
<th>Degree of Nonconformance</th>
<th>Percent of Contract Price to be Reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 to 3.0</td>
<td>2</td>
</tr>
<tr>
<td>3.1 to 5.0</td>
<td>4</td>
</tr>
<tr>
<td>5.1 to 8.0</td>
<td>7</td>
</tr>
<tr>
<td>8.1 to 12.0</td>
<td>11</td>
</tr>
<tr>
<td>Greater than 12</td>
<td>*</td>
</tr>
</tbody>
</table>

* The Division will make a special evaluation of the material and determine the appropriate action.

604.15-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>604037-*</td>
<td>“size” Reinforced Concrete Pipe, Class **</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604038-*</td>
<td>“size” Reinforced Concrete Pipe End Section</td>
<td>Each</td>
</tr>
<tr>
<td>604039-*</td>
<td>“size” Reinforced Concrete Pipe Arch, Class **</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604040-*</td>
<td>“size” Reinforced Concrete Pipe Arch End Section</td>
<td>Each</td>
</tr>
<tr>
<td>604041-*</td>
<td>“size” Reinforced Concrete Elliptical Pipe, X</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604045-*</td>
<td>“size” Polypropylene Pipe</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604050-*</td>
<td>“size” High Density Polyethylene Pipe, profile wall</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604051-*</td>
<td>“size” High Density Polyethylene Pipe, steel reinforced</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604052-*</td>
<td>“size” Polyvinyl Chloride Pipe</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604053-*</td>
<td>“size” Relaid Existing Pipe</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604054-*</td>
<td>“size” Jacked Pipe, Reinforced Concrete Pipe, Class **</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604070-*</td>
<td>“size” Precast Concrete Box Culvert</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604071-*</td>
<td>“size” Reinforced Concrete Pipe Safety Slope End Section</td>
<td>Each</td>
</tr>
<tr>
<td>604073-*</td>
<td>“size” Elliptical Reinforced Concrete Pipe Safety Slope End Section, X</td>
<td>Each</td>
</tr>
<tr>
<td>604074-*</td>
<td>“size” Aluminum Structural Plate Box Culvert, YZ</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604076-*</td>
<td>“size” Aluminum Coated Corrugated Steel Pipe, YZ</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604077-*</td>
<td>“size” Aluminum Coated Corrugated Steel Pipe Arch, YZ</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604080-*</td>
<td>&quot;size” Aluminum Coated Corrugated Steel Pipe and Paved Invert</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>604090-*</td>
<td>“size” Corrugated Steel Pipe End Section</td>
<td>Each</td>
</tr>
<tr>
<td>604091-*</td>
<td>“size” Corrugated Steel Pipe Arch End Section</td>
<td>Each</td>
</tr>
<tr>
<td>604092-*</td>
<td>“size” Corrugated Steel Pipe Safety Slope End Section</td>
<td>Each</td>
</tr>
</tbody>
</table>

* Sequence number
** Class designated by Roman numerals. “special design” may be used for unique circumstance
X = Type of elliptical pipe in accordance with the following table
Y = Base metal thickness in accordance with the following table.
Z = A one digit number designating metal pipe corrugations in accordance with the following table.
For Aluminum Box Culverts, haunch and crown plate thicknesses as specified on the Plans
<table>
<thead>
<tr>
<th>Y</th>
<th>Mil Thickness</th>
<th>Z</th>
<th>Metal Corrugations</th>
<th>Pipe Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>64 (1.63)</td>
<td>60 (1.52 mm)</td>
<td>1½&quot; x ¼&quot;</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>79 (2.0)</td>
<td>75 (1.90 mm)</td>
<td>2/3&quot; x ½&quot;</td>
<td>---</td>
</tr>
<tr>
<td>C</td>
<td>109 (2.77)</td>
<td>105 (2.67 mm)</td>
<td>3&quot; x 1&quot;</td>
<td>---</td>
</tr>
<tr>
<td>D</td>
<td>138 (3.51)</td>
<td>135 (3.43 mm)</td>
<td>5&quot; x 1&quot;</td>
<td>---</td>
</tr>
<tr>
<td>E</td>
<td>168 (4.27)</td>
<td>164 (4.27)</td>
<td>6&quot; x 2&quot;</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100 (2.54 mm)</td>
<td>7½&quot; x ¾&quot; x ¾&quot;</td>
<td>---</td>
</tr>
<tr>
<td>F</td>
<td>188 (4.78)</td>
<td>---</td>
<td></td>
<td>I or 1</td>
</tr>
<tr>
<td>G</td>
<td>218 (5.54)</td>
<td>---</td>
<td></td>
<td>II or 2</td>
</tr>
<tr>
<td>H</td>
<td>249 (6.32)</td>
<td>---</td>
<td></td>
<td>III or 3</td>
</tr>
<tr>
<td>J</td>
<td>4 BOLTS/FT (13 BOLTS/M) 280 (7.11)</td>
<td>---</td>
<td></td>
<td>IV or 4</td>
</tr>
<tr>
<td>K</td>
<td>6 BOLTS/FT (19 BOLTS/M) 280 (7.11)</td>
<td>100 (2.54 mm)</td>
<td></td>
<td>V or 5</td>
</tr>
<tr>
<td>L</td>
<td>8 BOLTS/FT (26 BOLTS/M) 280 (7.11)</td>
<td>125 (3.18 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>313 (7.95)</td>
<td>150 (3.81 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>375 (9.52)</td>
<td>185 (4.41 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>---</td>
<td>200 (5.08 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>---</td>
<td>225 (5.72 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>---</td>
<td>250 (6.35 mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Concrete Pipe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Horizontal Elliptical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>Vertical Elliptical</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 708
JOINT MATERIALS

DELETE THE CONTENTS SUBSECTIONS 708.5, 708.6, 708.7, AND 708.8 AND REPLACE WITH THE FOLLOWING:

708.5 through 708.8: Blank

DELETE THE CONTENTS AND TITLE OF SUBSECTION 708.9 AND REPLACE WITH THE FOLLOWING:

708.9-BITUMEN SEALANT:
Bitumen Sealant used as a joint sealer for concrete and masonry shall meet the requirements of ASTM C990.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 713
METAL PIPE

713.1-Blank

713.2-METALLIC COATED CORRUGATED STEEL PIPE AND PIPE ARCH:
Metallic coated corrugated steel pipe and pipe arch shall conform to the requirements of AASHTO M 36 for Type I and Type II pipe.
Special sections, such as elbows, for these conduits shall be of the same gage as the conduit to which they are jointed, and shall conform to the applicable requirements of AASHTO M 36.

713.3-ASPHALT COATED CORRUGATED STEEL PIPE AND PIPE ARCH:
Asphalt coated corrugated steel pipe, pipe arches, coupling bands, elbows, and other special sections shall conform to the requirements of AASHTO M 190. Coating and invert paving shall be of the type specified.

713.4 through 713.17: Blank

713.18-ALUMINUM ALLOY STRUCTURAL PLATE FOR BOX CULVERT:
Box culvert and the bolts and nuts for connecting plates shall conform to the requirements of AASHTO M 219.

713.19-Blank

713.20-END SECTIONS FOR CORRUGATED STEEL PIPE AND PIPE ARCHES:
End sections for corrugated iron or steel pipe and pipe arches shall be of the thickness recommended by the manufacturer, and they shall conform to the applicable requirements of AASHTO M 36 and the details shown on the Plans.

713.21 through 713.23: Blank

713.24-ALUMINUM COATED CORRUGATED STEEL PIPE AND PIPE ARCH:
These conduits shall conform to AASHTO M 36 requirements for aluminum coated or aluminum-zinc coated corrugated steel pipe and pipe arch.
DELETE THE ENTIRE CONTENTS AND HEADING AND REPLACE WITH THE FOLLOWING:

SECTION 714
CONCRETE AND PLASTIC PIPE

714.1-Blank

714.2-REINFORCED CONCRETE CULVERT, STORM DRAIN AND SEWER PIPE:
This pipe shall conform to the requirements of AASHTO M 170 or ASTM C 76, AASHTO R 73, and MP 714.03.30. Class III, IV, and V reinforced concrete pipe are to be used.

714.2.1–Special Design: When reinforced concrete pipe pay item includes Special Design designation, the following shall apply per designation in the plans.

714.2.1.1-Structural: High fill cover heights, minimal cover heights, or excessive loads, which require special reinforcing and design of reinforced concrete pipe.

714.2.1.2-Cement Content: Corrosive environments, which require special concrete mix to improve the sulfate resistance. Table 714.2.1.2 illustrates the material requirements for a given sulfate concentration.

<table>
<thead>
<tr>
<th>Relative Degree of Sulfate Attack</th>
<th>% Water-Soluble Sulfate in Soil Samples</th>
<th>PPM Sulfate in Water Samples</th>
<th>Min. Cement Content (lbs/cy)</th>
<th>Max. Water/Cement Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negligible</td>
<td>0.00 – less than 0.1</td>
<td>0 – less than 150</td>
<td>470</td>
<td>0.53</td>
</tr>
<tr>
<td>Positive</td>
<td>0.10 – less than 0.2</td>
<td>150 – less than 1,500</td>
<td>470</td>
<td>0.53</td>
</tr>
<tr>
<td>Severe</td>
<td>0.20 - 2.00</td>
<td>1,500 - 10,000</td>
<td>517</td>
<td>0.4</td>
</tr>
<tr>
<td>Very Severe</td>
<td>Greater than 2.00</td>
<td>Greater than 10,000</td>
<td>658</td>
<td>0.35</td>
</tr>
</tbody>
</table>
714.3-REINFORCED CONCRETE ARCH CULVERT, STORM DRAIN AND SEWER PIPE:
This pipe shall conform to the requirements of AASHTO M 206 or ASTM C 506.

714.4-REINFORCED CONCRETE ELLIPTICAL CULVERT, STORM DRAIN AND SEWER PIPE:
This pipe shall conform to the requirements of AASHTO M 207 or ASTM C 507 and AASHTO R 73.

714.5-PERFORATED CONCRETE PIPE:
This pipe shall conform to the requirements of AASHTO M 175 or ASTM C 444.

714.6-Blank

714.7-PRECAST REINFORCED CONCRETE BOX CULVERTS:
Precast reinforced concrete box culverts shall conform to the requirements of ASTM C1577. Interstate live load design shall be provided for Interstate highway facilities and HL 93 live load design shall be provided for other locations.

All fabricators of precast reinforced concrete box culverts shall maintain an adequate level of quality control. Plant certification by NPCA (National Precast Concrete Association), ACPA (American Concrete Pipe Association) plant certification for box culverts, or other approved equal certification program will be required to verify this level of quality control. Plant approval must be obtained prior to the start of fabrication. All Fabricators shall then submit evidence of Plant approval to the MCS&T Division on an annual basis.

All box culverts shall be cured in accordance with section 601.12 or 603.8 except that curing may be discontinued once 70% of the design strength is achieved. All box culverts shall meet design strength prior to shipment.

714.7.1-Trial Fitting: For box culverts, trial fitting of adjacent pieces, prior to shipping, will be required as part of the final inspection process, at a minimum of twenty-five percent (25%) of the project total. Adjacent box culverts will either be stacked in pairs vertically or placed horizontally as to be installed. The gaps between each pair will be measured, and dunnage will be placed below the culvert(s) to prevent damage. The maximum gap between the adjacent pieces shall not exceed ½ inch (13 mm), unless otherwise stated in the construction plans.

714.7.2-Price Adjustments: Box culverts not achieving the 28 day shipping strength, but for which evaluation indicates may still be used, will be paid for at a reduced price in accordance with the following formulas, depending on who purchased the box culverts:

Formula 1: Use the following price reduction formula when the box culverts are used in a project constructed by the Contractor:

\[
\text{Price Reduction} = \left( \frac{f'_{c} - \bar{X}}{0.5 f'_{c}} \right) \times 40\% \text{ of the Contract Unit Bid Price}
\]
Formula 2: Use the following price reduction formula when the box culverts are used in a project constructed by the Division:

\[
\text{Price Reduction} = \left( \frac{f'_c - \bar{X}}{0.5 f'_c} \right) \times \text{IC}
\]

Where:

- \( f'_c \) = 28-Day Compressive Strength, psi (MPa)
- \( \bar{X} \) = Average 28-Day Compressive Strength as determined by a minimum of 2 compressive strength test cylinders fabricated from a batch of concrete as it was placed in the forms for the box culverts

- \( \text{IC} \) (Formula 2 only) = The invoiced cost of the box culvert itself, as billed to the Division by the Fabricator. This cost shall not include other items associated with the box culverts such as gaskets or etc.

**714.8-CONCRETE END SECTIONS:**
Precast reinforced concrete end sections shall conform to the requirements of the cited Specifications for the pipe to the extent to which they apply and to the details shown on the Plans.

**714.9 through 714.16: Blank**

**714.17-POLYPROPYLENE PIPE:**
For nominal pipe sizes of 12 inches to 60 inches (150 to 1500 mm) dual wall pipe and fittings meet the requirements of ASTM 2881M or AASHTO M 330.

**714.18-HIGH DENSITY POLYETHENE (STEEL REINFORCED):**
The pipe and fittings of nominal sizes 12 inch (150 mm) through 60 inches (1500 mm) shall conform to the requirements of AASHTO MP20.

**714.19-HIGH DENSITY POLYETHYLENE PIPE (PROFILE WALL):**
Corrugated polyethylene pipe shall be accordance with the following:
1. For nominal pipe sizes of 3 to 6 inches (75 to 150 mm) when perforations are required the pipe shall meet the requirements of AASHTO M 252 with class 2 perforations.
2. For nominal pipe sizes of 3 to 10 inches (75 to 250 mm) when perforations are not required the pipe shall meet the requirements of AASHTO M 252 type “S” only.
3. For nominal pipe sizes of 12 to 60 inches (300 to 1 500 mm) the pipe shall meet the requirements of AASHTO M 294 type “S” or type “D” only.

**714.20-PERFORATED PLASTIC SEMICIRCULAR PIPE:**
Perforated plastic semicircular pipe shall be extruded or molded using a high density, flexible plastic.
The pipe shall have a smooth or corrugated top and a smooth semicircular bottom, averaging 4-5/8 inches (116 mm) in diameter, with perforations uniformly distributed along the top of the semicircular section. The perforations shall be not less than 1/4 inch (6 mm) nor more than 3/8 inch (10 mm) in diameter, and shall provide a minimum intake area of one square inch...
per linear foot (2100 sq. mm per m). Minimum material thickness shall be 1/8 in. (3 mm). The
top flange shall extend a minimum of ½ in. (13 mm) beyond the top of the semi-circular section.

A one foot (300 mm) section of pipe shall deflect no more than 1½ at an applied load of
900 lb. (38 mm), using the Parallel Plate Load Test of ASTM D 2412. Fifteen minutes after
removal of the load, the pipe section shall have recovered not less than 50 percent of its deflection
at 900 lb. (4 kN).

714.21-Blank

714.22-POLYVINYL CHLORIDE (PVC) PIPE:
The pipe and fittings shall conform to the requirements of AASHTO M278, ASTM D3034
or ASTM F949.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 606
UNDERDRAINS

606.1-DESCRIPTION:

DELETE THE CONTENTS AND REPLACE WITH THE FOLLOWING:

This work shall consist of constructing underdrains and free draining base trenches using pipe and granular material, blind drains, aggregate filled engineering fabric, prefabricated pavement edge drain and underdrain pipe outlets in accordance with these Specifications and in reasonably close conformity with the lines, grades, dimensions and locations shown on the Plans or established by the Engineer.

When Item 606025-*, “size” Underdrain Pipe, is included as a pay item in the Contract, any of the following pipe types may be furnished for construction of the underdrain: corrugated polyethylene underdrain pipe, or perforated plastic semicircular pipe.

606.1.1-Free Draining Base Trench: This work shall consist of constructing free draining base trenches and Outlet Pipes in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and locations shown on the plans or established by the Engineer.

606.2-MATERIALS:

DELETE THE CONTENTS AND REPLACE WITH THE FOLLOWING:

Material shall meet the requirements specified in the following Subsections of Division 700:

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>SUBSECTION</th>
<th>TYPE OR GRADATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete for Miscellaneous Uses</td>
<td>715.12</td>
<td></td>
</tr>
<tr>
<td>Corrugated Polyethylene Underdrain</td>
<td>714.19</td>
<td></td>
</tr>
<tr>
<td>Crushed Aggregate for Free Draining Base Trench</td>
<td>703.1, 703.2, 703.3, 703.4</td>
<td>AASHTO 57, 67, 357, or 467</td>
</tr>
<tr>
<td>Crushed Gravel for Aggregate Filled Fabric</td>
<td>703.2 &amp; 703.4</td>
<td>AASHTO #2 thru</td>
</tr>
<tr>
<td>MATERIAL</td>
<td>SUBSECTION</td>
<td>TYPE OR GRADATION</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Underdrains ²</td>
<td>or 703.2.3</td>
<td>#57 or Pea Gravel</td>
</tr>
<tr>
<td>Crushed Gravel for Underdrains ²</td>
<td>703.2 &amp; 703.4</td>
<td>AASHTO Size # 57, 67, 7 or 78</td>
</tr>
<tr>
<td>Crushed Stone for Aggregate Filled Fabric Underdrains ²</td>
<td>703.1 &amp; 703.4</td>
<td>AASHTO #2 thru #57 inclusive</td>
</tr>
<tr>
<td>Crushed Stone for Underdrains ²</td>
<td>703.1 &amp; 703.4</td>
<td>AASHTO Size # 57, 67, 7 or 78</td>
</tr>
<tr>
<td>Engineering Fabric for Subsurface Drainage</td>
<td>715.11.4</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Concrete</td>
<td>715.12</td>
<td></td>
</tr>
<tr>
<td>Perforated Plastic Semicircular Pipe ¹</td>
<td>714.20</td>
<td></td>
</tr>
<tr>
<td>Prefabricated Pavement Edge Drain</td>
<td>715.10.1</td>
<td></td>
</tr>
<tr>
<td>Silica Sand for Underdrains</td>
<td>702.1.2, 702.1.3 &amp; 702.6</td>
<td></td>
</tr>
</tbody>
</table>

1 Plastic semicircular pipe may be furnished only when six inch (150 mm) diameter is called for on the Plans.
2 Only one size may be used at any one installation.

When the locations of manufacturing plants allow, the plants may be inspected periodically for compliance with specified manufacturing methods, and material samples may be obtained for laboratory testing for compliance with material quality requirements. This may be the basis for acceptance of manufacturing lots as to quality. All materials will be subject to inspection for acceptance as to condition at the latest practicable time the Engineer has the opportunity to check for compliance prior to or during incorporation of materials in the work.

606.2.1-Quality Control Testing: Quality control is the responsibility of the Contractor as specified in 106.1. The contractor shall develop a quality control plan in accordance with applicable sections of MP 307.00.50 excluding the attachment page.

Samples will be obtained at a minimum frequency of one sample per day of aggregate placement. Aggregate for underdrain shall be evaluated for specification compliance in accordance with MP 606.03.50. Aggregate for aggregate filled underdrain shall be evaluated for specification compliance in accordance with MP 606.03.50 except Section 6.0 through 6.2 are excluded.

606.2.2-Acceptance Testing: Acceptance sampling and testing of aggregates used for underdrain is the responsibility of the Division, Except for furnishing the necessary materials. Quality control sampling and testing performed by the Contractor may be used by the Division for Acceptance.

606.2.3-Free Draining Base Trench Materials: The perforated pipe as detailed on the plans shall meet the requirements of this Section. The Outlet pipe as detailed on the plans shall meet the requirements of Subsection 715.10.1.5.
606.3-CONSTRUCTION METHODS:
606.3.1-Pipe Installation:

DELETE SUBSECTION 606.3.1.2 AND 606.3.1.3 AND REPLACE WITH THE FOLLOWING:

606.3.1.2-Bedding and Placing Pipe: A minimum 4 inch (100 mm) bedding layer of crushed gravel or crushed stone shall be placed in the bottom of the trench for its full width and length.

Subdrainage pipe of the type and size specified shall be embedded firmly in the bedding material. Upgrade ends of all underdrainage pipe installations shall be closed with suitable plugs to prevent entry of soil materials.

Perforated pipe shall normally be placed with the perforations down. Flexible pipe sections shall be joined with couplings or bands as recommended by the manufacturer.

Non-perforated pipe and rigid pipe shall be firmly set and laid with the bell and groove ends upgrade and with open joints, wrapped with suitable material when specified, to permit entry of water.

606.3.1.3-Placing Filter Material: After the pipe installations have been inspected and approved, crushed stone or crushed gravel shall be placed to a height of 6 inches (150 mm) above the top of pipe. The trench shall then be filled with silica sand to a minimum thickness of 12 inches (300 mm) over the top of the filter stone or crushed gravel. In the event damp trench sides indicate the necessity; the Engineer may direct an increase in the thickness of the silica and cover. When the underdrain is used to drain the base or subbase, course, the sand filter shall be carried vertically to the bottom of the base or subbase. Care shall be taken not to displace the pipe or the covering at open joints. When there is a heavy percolation of water into the trench at underdrain level, the Engineer may substitute sand for the crushed stone or crushed-gravel bedding, cover and filter.

606.3.5-Free Draining Base Trench Construction Methods:

DELETE SUBSECTION 606.3.5.2 AND REPLACE WITH THE FOLLOWING:

606.3.5.2-Bedding and Placing Perforated Pipe: After excavating the trench, Engineering fabric shall be placed in the trench in reasonable conformance with the shape of the trench. The Engineering fabric shall be smooth and free of tension, stress, folds, wrinkles, or creases. The Engineering fabric shall be installed so that any splice joints have a minimum overlap of at least 1 foot (300 mm) any direction. Enough Engineering fabric will be placed in order to properly tie to the mainline placement of Engineering fabric (Item 207034 - *). A 2 inch (50 mm) bedding layer of crushed stone or crushed-gravel aggregate shall be placed in the bottom of the trench for its full width and length. The pipe shall then be placed in the trench. The pipe sections shall be joined with couplings or bands as recommended by the manufacturer. After pipe installation, the remainder of the trench will be backfilled with crushed stone or crushed-gravel aggregate. (refer to table in section 606.2 for material requirements of aggregate)
606.4-METHOD OF MEASUREMENT:

The quantity of work done will be measured by the linear foot (meter) for pipe, including outlet pipe, for each of the types and sizes as specified, complete in place and accepted. Length will be determined from actual measurements after the pipe is in place. Angles, tees, and wyes, and other branches which may be required will be measured from centerline of main pipe along the centerline of the branch to the end and the length included in the pipe length. Crushed stone, gravel, or silica sand for bedding, filter, and spring control will be measured by the volume; the volume will be the product of the specified trench width and depth, and the length in place, less the volume of the pipe computed on the basis of the outside diameter of the barrel or corrugations. Blind drains will be measured by the volume of granular material. The quantity of work done for "Aggregate Filled Fabric Underdrains" will be measured in linear feet (meters) of trench, complete in place and accepted. The quantity of work done for "Prefabricated Edge Drain" will be measured in linear feet (meters) of edge drain and outlet pipe, complete in place and accepted. Volume will be computed on the basis of the specified trench depth and width, and the length in place. Underdrain junction boxes will be measured by the unit. Slope walls for underdrains will not be paid for separately, but shall be included in the cost of the underdrain pipe.

606.6-PAY ITEMS:

DELETE THE CONTENTS AND REPLACE WITH THE FOLLOWING:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>606020.*</td>
<td>Aggregate Filled Fabric Underdrains, “size”</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>606022.*</td>
<td>Crushed Stone, Crushed Gravel, or Silica Sand for Underdrains</td>
<td>Cubic Yard (Meter)</td>
</tr>
<tr>
<td>606025.*</td>
<td>“size” Underdrain Pipe</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>606027.*</td>
<td>Corrugated Polyethylene Underdrainage Pipe</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>606029.*</td>
<td>Free Draining Base Trench</td>
<td>Linear Foot (Meter)</td>
</tr>
<tr>
<td>606030.*</td>
<td>Outlet Pipe, “size”</td>
<td>Linear Foot (Meter)</td>
</tr>
</tbody>
</table>

* Sequence number
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

SECTION 655
MATTING FOR EROSION CONTROL

655.1-DESCRIPTION:

ADD THE FOLLOWING SUBSECTION:

655.1.1-Tied Concrete Block Erosion Mat: This work shall consist of furnishing and placing the Tied Concrete Block Erosion Control Mat (TCBM) in accordance with this Special Provision and in reasonably close conformity with the lines, grades, design, and dimensions shown on the plans.

The TCBM shall be manufactured or field fabricated from integrally formed individual concrete blocks tied together with high strength geogrid or pre-approved cable system.

655.2-MATERIALS:

ADD THE FOLLOWING SUB-SECTIONS:

655.2.1-Panel: The concrete blocks, cables, geogrid, fittings and other applicable elements shall be manufactured or fabricated into mats.

655.2.2-Concrete Blocks: Concrete block shall be tapered, beveled, and interlocked. The blocks shall incorporate interlocking surfaces or connections that prevent lateral displacement of the blocks within the mats when they are lifted for placement. Blocks shall exhibit resistance to mild concentrations of acids, alkalis, and solvents.

All Concrete Mix Designs which will be used on products fabricated for the WVDOH must be submitted for review & approval, prior to the start of fabrication. Sampling and testing of component materials shall be done in accordance with MP 603.02.10.

Blocks shall be wet-cast and conform to the requirements of MP 604.02.40 and Table 655.2.2. Concrete cylinders shall be made for compressive strength testing with 6-inch by 12-
inch (150 mm by 300 mm) or 4-inch by 8-inch (100 mm by 200 mm) molds. The cylinders are to be cured in the same area as the products for which they represent (Field Cured as outlined in AASHTO T23) until tested to create a curing environment similar to the product that they represent. A compressive strength test shall consist of the average result of a set of cylinders, which is at least two cylinders.

A minimum of one set of compressive strength cylinders shall be fabricated for every 50 yd$^3$ (38 m$^3$) of concrete that is produced, or once per half-day of production, whichever is less, to verify that the requirements of Table 655.2.2 are met. Both the form removal strength and the 28-day strength must be confirmed by a set of cylinders. Cylinders shall be the same size as those used in the initial approved mix design.

For conventional concrete, slump, temperature, and air content tests shall be conducted on the first batch of concrete each day and every time that cylinders are fabricated. For SCC mixes, spread, temperature, and air content tests shall be conducted on every batch. For all types of concrete, unit weight and yield tests shall be conducted on the first batch of concrete each day and thereafter as deemed necessary by Quality Control and Quality Assurance Personnel. The Fabricator shall perform an absorption test on one random block per five days of production in accordance with ASTM C642-13. After fabrication is completed and prior to shipment each mat shall be inspected to insure it meets all specification requirements and does not contain any defects, the Inspector will stamp the precast product invoice as accepted by MCS&T Division and provide a 7-digit Laboratory Reference Number for shipment.

<table>
<thead>
<tr>
<th>Minimum 28-day Compressive Strength (AASHTO T22 and T23)</th>
<th>Maximum Water Absorption after immersion and boiling (ASTM C642)</th>
<th>Air Content AASHTO T 152</th>
<th>Consistency (Slump) AASHTO T 119</th>
<th>Percentage Open Area (POA) within an individual panel</th>
<th>Unit Weight and Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,000 psi (28 Mpa)</td>
<td>9.0%</td>
<td>7 ± 2%</td>
<td>Target ± 1.5 in. (38 mm)</td>
<td>30%</td>
<td>±2% of Theoretical</td>
</tr>
</tbody>
</table>

**TABLE 655.2.2 Physical Requirements**

655.2.3-Polypropylene Geogrid: The TCBM shall be constructed of a high strength, rough service, low elongating, and continuous filament polypropylene geogrid with an acrylic coating. Interlocking geogrid shall have the following physical properties:

<table>
<thead>
<tr>
<th>Mass/Unit Area</th>
<th>ASTM D-5261 7.0 oz./yd2 (240 g/m2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture Size</td>
<td>ASTM D-5261 7.0 oz./yd2 (240 g/m2)</td>
</tr>
<tr>
<td>Wide Width Tensile Strength</td>
<td>Machine Direction (MD) ASTM D-6637 2,055 lb./ft. (30 kN/m)</td>
</tr>
<tr>
<td>Elongation at Break</td>
<td>ASTM D-6637 6 % (6%)</td>
</tr>
<tr>
<td>Tensile Strength @ 2%</td>
<td>Machine Direction (MD) ASTM D-6637 822 lb./ft. (12 kN/m)</td>
</tr>
<tr>
<td>Tensile Strength @ 5%</td>
<td>Machine Direction (MD) ASTM D-6637 1,640 lb./ft. (24 kN/m)</td>
</tr>
<tr>
<td></td>
<td>Cross Machine Direction (CMD) ASTM D-6637 2,055 lb./ft. (30 kN/m)</td>
</tr>
<tr>
<td></td>
<td>Cross Machine Direction (CMD) ASTM D-6637 822 lb./ft. (12 kN/m)</td>
</tr>
<tr>
<td></td>
<td>Cross Machine Direction (CMD) ASTM D-6637 1,640 lb./ft. (24 kN/m)</td>
</tr>
<tr>
<td>Tensile Modulus @ 2%</td>
<td>Machine Direction (MD) ASTM D-6637 41,100 lb./ft. (600 kN/m)</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Tensile Modulus @ 5%</td>
<td>Machine Direction (MD) ASTM D-6637 32,900 lb./ft. (480 kN/m)</td>
</tr>
</tbody>
</table>

655.2.4-Underlayment: The backing material shall be rolled up with the TCBM and shall include the minimum of a double-net excelsior (wood fiber) blanket so when the system is unrolled the backing becomes the underlayment to stabilize the soils and promote growth of vegetation, unless otherwise specified on the plans. Alternate underlayment options include permanent erosion control matting per 715.24.2 type A and engineering fabric for erosion control per 715.11.6.

655.2.5-Transportation, Handling, and Storage: Upon delivery to the project, the Contractor shall inspect the TCBM for type, size, quantity, quality, and condition, to ensure that the proper material has been delivered and no damage occurred during transportation. Defects or damage will be cause for rejection, and immediate steps shall be taken to replace, at no additional cost.

TCBM with excelsior fiber backing may be left exposed for up to 30 days. If exposure will exceed 30 days, the rolls must be tarped or otherwise covered to minimize UV exposure.

655.2.6-Visual Inspection: All units shall be free of defects that would interfere with the proper placing of the unit or impair the strength and permanence of the overall system.

Surface cracks incidental to the normal manufacture of concrete shall not be deemed grounds for rejection. Cracks exceeding 0.25 inches in width and/or 1.0 inch in depth shall be deemed grounds for rejection and unit replacement.

Surface chipping resulting from customary methods of manufacture, shipping, handling and installation shall not be grounds for rejection. Chipping resulting in a weight loss exceeding 15% of the average weight of a concrete unit shall be deemed grounds for rejection and unit replacement.

CONSTRUCTION METHODS

655.3-PLACING:

ADD THE FOLLOWING SUB-SECTIONS:

655.3.8-Tied Concrete Block Erosion Mat:

655.3.8.1-Subgrade Preparation: The prepared subgrade shall provide a firm, unyielding foundation for the mats. The subgrade shall be prepared as detailed on the plans. Subgrade surface shall be free of any debris, protrusions, rocks, sticks, roots or other hindrances which would result in an individual block being raised more than ¾” above the adjoining blocks. Undulations, rolls, knolls and rises in the subgrade to which the TCBM is able to contour over and maintain intimate contact with the subgrade will be allowed. Apply seed directly to the prepared soil prior to installation of mats. Use seed and/or topsoil per project specifications. Install mats to the line and grade shown on the plans and
according to the manufacturer’s installation guidelines. The manufacturer or authorized representative will provide technical assistance during installation as needed.

655.3.8.2-Anchorong: The upstream end of the TCBM is to be embedded 18 inches to prevent undermining of the mat. This also provides anchorage when the mats are installed on steeper slopes. Edges exposed to concentrated flows, such as side channels, shall also be embedded 18 inches. Edges exposed to sheet flow shall have the row of blocks along that edge embedded into the soil.

In instances where the TCBM cannot be embedded into the soil, such as when it is placed on a rock foundation, mechanical anchorage may be required. The polypropylene grid cast into the concrete blocks shall be attached to the anchoring system as indicated on the Contract Drawings. An engineered anchoring system, such as a percussion anchor that loops around lengths of rebar placed over the grid and in between the blocks, may be used. The design and layout of the anchoring system shall be by the Engineer, or a party designated by the Engineer.

The site should allow for manipulation of the mat during installation to achieve proper positioning and placement through the use of standard construction equipment including, but not limited to; excavator, forklift, skid-steer, or other under supervision of approved manufacturer representative.

655.3.8.3-Panel Seaming: Panel seams (Channel and Slopes) perpendicular to the hydraulic flow must be overlapped. The downstream panel will be terminated and properly anchored according to Contract Drawings. The upstream panel will then overlap the downstream panel by 18 to 24 inches. If no hydraulic or overland flow is expected, butting the seams together is acceptable. A 4 foot section of erosion control matting is used with 2 foot being placed under the mats on each side of the seam.

655.7-PAY ITEMS:

ADD THE FOLLOWING ITEM TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>655002-002</td>
<td>Tied Concrete Block Mattress</td>
<td>Square Yard (Meter)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR

ADD THE FOLLOWING SECTION:

SECTION 420
SINGLE / MULTIPLE COURSE MICRO SURFACING

420.1-DESCRIPTION:
This section covers the materials, equipment, construction and application procedures for placing Micro Surfacing material for filling ruts and for surfacing existing paved surfaces. The Micro Surfacing is a mixture of a latex-modified asphalt emulsion, crushed mineral aggregate screenings, mineral filler, water and other additives for control of set time in the field. All ingredients are to be properly proportioned, mixed and spread on the paved surface in accordance with this Specification and as directed by Engineer.

420.2-MATERIALS:
Furnish a Micro Surfacing mixture consisting of a properly designed and proportioned blend of polymerized asphalt emulsion, fine aggregate, Portland cement, water and other additives. Use materials meeting the following:

420.2.1-Mineral Filler: Portland cement, hydrated lime, limestone dust, fly ash, or other approved filler meeting the requirements of ASTM D 242 shall be used if required by the mix design.

420.2.2-Fine Aggregates, 2FA and 3FA: The fine aggregate used shall be suitable for the particular application and shall be a crushed stone such as granite, slag, limestone, chat, or other high-quality aggregate, or combination thereof and shall meet the requirements of the Division of Highways and grading requirements as stated. In addition, aggregates used for surface courses on projects with an ADT greater than 3000 shall be from an approved source identified as having polish-resistant aggregates and considered potential skid-resistant aggregate sources.

<table>
<thead>
<tr>
<th>Tests</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalent Value of Soils and Fine Aggregate</td>
<td>ASTM D 2419, AASHTO T176</td>
</tr>
</tbody>
</table>
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

<table>
<thead>
<tr>
<th>Material</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/8 in</td>
</tr>
<tr>
<td>2FA (a)</td>
<td>100</td>
</tr>
<tr>
<td>3FA (a)</td>
<td>100</td>
</tr>
</tbody>
</table>

(a) Gradation represents the final blended product.

420.2.3-Asphalt Emulsion-CSS-1hM or CQS-1hM: Polymer Modified Asphalt Emulsion shall be a quick-set, CSS-1hM or CQS-1hM emulsion in accordance with AASHTO M 208-316 except the cement-mixing test is waived. The polymer material shall be processed into the asphalt cement or milled into the asphalt emulsion. Post adding to the asphalt emulsion is not permitted. The minimum polymer solids content will be 3.0% based on the residual of the emulsion.

Tests ASTM D-244 AASHTO T 59, Unless Otherwise Designated

- Viscosity, Saybolt Furol, ASTM D-88, @ 25 °C, sec: 20 – 100
- Storage Stability Tests, 24-hr, % Difference, max: 1
- Particle Charge Tests: Positive
- Sieve Tests, % max (Distilled Water): 0.10
- Distillation to 260-177 °C hold 20 min, % by Weight, min.: 60

Tests on Distillation Residue

- Penetration, 25 °C, 100 g, 5 sec, dmm, ASTM D-5 AASHTO T 49: 40 – 90
- Ductility, 25 °C, 5 cm/min, cm, min, ASTM D-113 AASHTO T 51: 40
- Solubility in Trichloroethylene, % min, ASTM D-2042 AASHTO T 44: 97.5

420.2.4-Water: Water shall be potable and free of harmful salts and contaminants.

420.2.5-Additives: Chemical additives may be used to accelerate or retard the break/set of the Micro Surfacing mixture if required by the mix design.

420.3-MIXTURE REQUIREMENTS:

420.3.1-Mix Design: Submit to the Engineer, at least fourteen calendar days before the start of production, a complete mix design prepared and certified by an experienced laboratory. Provide a job mix formula (JMF) to the Engineer at the pre-paving meeting showing individual proportions of each material, that when combined, will meet the following mix design criteria. A new mix design is required for any change in aggregate or asphalt emulsion source.
**Micro Surfacing Mix Design Criteria**

| **ISSA TB-139 Wet Cohesion** | 30 minutes minimum (set time) 12 kg-cm min  
60 minutes minimum (traffic) 20 kg-cm min or near spin |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ISSA TB-114 Wet Stripping</strong></td>
<td>90% min</td>
</tr>
</tbody>
</table>
| **ISSA TB-100 Wet Track Abrasion Loss** | One Hour Soak 50 g/ft2 max  
Six Day Soak 75 g/ft2 max |
| **ISSA TB-144 Saturated Abrasion Compatibility** | 3 g loss, max |
| **ISSA TB-113** | Mix Time at 77 °F* Controllable to 120 sec, min  
Mix Time at 104 °F* Controllable to 35 sec, min |

* Check the ISSA TB-139 (set time) and ISSA TB-113 (mix time) tests at the highest temperature expected during construction. For ISSA TB-113 test at 104°F, preheat all ingredients and containers.

The JMF must be within the following limits:

| Asphalt Binder Content (Residual) | 7.0%-8.5%, dry weight, 2FA aggregate  
6.5%-8.0%, dry weight, 3FA aggregate |
| Mineral Filler | 0.25%-3.0%, dry weight, of aggregate |

**420.3.2-Mix Design Format:** Provide the following information in the final mix design:

a. Sources of each material
b. Aggregate
   1. Type
   2. Gradation
   3. Sand equivalence
c. Field Simulation Tests
   1. Wet stripping test
   2. Wet track abrasion loss
   3. Saturated abrasion compatibility
   4. Trial mix time at 77 °F and 100 °F
d. Interpretation of results and the determination of a JMF
   1. Mineral filler (minimum & maximum), percent
   2. Water, including aggregate moisture (minimum & maximum), percent
   3. Quantitative effects of moisture content on the unit weight of the aggregate
   4. Mix set additive (if required), percent
   5. Modified emulsion, percent
   6. Residual content of modified emulsion
   7. Residual, percent
e. Mix designer’s signature and date
420.4-CONSTRUCTION:

420.4.1-Equipment: Provide safe, environmentally acceptable equipment that can produce a specification product.

420.4.1.1-Mixing Machine: Provide one or more self propelled, front feed, continuous loading mixing machines equipped and operated as follows:

a. A positive connection conveyor belt aggregate delivery system and an interconnected positive displacement, water-jacketed gear pump to accurately proportion aggregate and asphalt emulsion.

b. Continuous flow, twin shaft, multi-blade type pugmill a minimum of 50 inches long.

c. Blade sizes and side clearances that meet the equipment manufacturer’s recommendation.

d. Mineral filler feed located to ensure that the proper quantity of mineral filler drops on the aggregate before discharging into the pugmill.

e. Asphalt emulsion introduced within the first one-third of the mixer length to ensure proper mixing of all materials before they exit from the pugmill.

f. Computerized material monitoring system with integrated material control devices that are readily accessible and positioned so the amount of each material used can be determined at any time. The mixer shall be equipped with a back-up electronic materials counter that is capable of recording running count totals for each material being monitored. The mixer shall be equipped with a radar ground measuring device. Each material control device shall be calibrated prior to each mix application and as often thereafter as deemed necessary by the Engineer. The computer system shall have the capability to record, display and print the following information:

1. Individual sensor counts for emulsion, aggregate, cement, water and additive

2. Aggregate, emulsion, and cement output in lbs. (kgs) per minute

3. Ground travel distance. The mixer shall be equipped with a Radar Ground metering device

4. Spread rate in lbs./s.y. (kgs/m²)

5. Percentages of emulsion, cement, water and additive

6. Cumulative totals of aggregate, emulsion, cement, water and additive

7. Scale factor for all materials


g. Equipped with a water pressure system and nozzle type spray bar to provide water spray ahead of and outside the spreader box when required. Apply water to dampen the surface without resulting in free flowing water ahead of the spreader box.

h. Opposite side driving stations on the front to optimize longitudinal alignment during placement. Remote forward speed control at the back mixing platform so that the back operator can control forward speed and level of mixture in the spreader box.

Use a sufficient number of transports to assure a continuous operation during mix production and application. Use transport units with belt type aggregate delivery systems, emulsion and water storage tanks of adequate size to proportionally mix aggregate delivered by each transport.

Page 4 of 9
Unless otherwise noted in the plans or as approved by the Engineer, truck-mounted batch type machines will only be allowed on small projects (15,000 square yards or less).

Provide a minimum of two units at all times. Schedule these truck-mounted machines so that mixture production is never delayed more than 15 minutes. Stop production anytime there is noncompliance with this requirement.

Calibrate the mixing machines before use. Maintain documentation of calibration of each material metering device at various settings. Supply all materials and equipment, including scales and containers, necessary for calibration. Recalibrate after all changes in aggregate or asphalt emulsion sources.

420.4.1.2-Spreader Box: Attached to the machine shall be hydraulically adjustable (adjustable while applying mixture) type spreader box with a positive screed adjustment for yield control and a positive adjustment for the joint matcher.

Equipped with paddles or augers mounted on adjustable shafts to continually agitate and distribute the mixture to prevent stagnation, excessive build-up, or lumps. Equip spreader boxes with front and rear flexible seals to maintain direct contact with the road. Use a secondary strike off attached to the spreader box to provide a finished smooth surface texture on the final pass or surface pass. Use a drag that produces a uniform finish.

420.4.1.3-Rut Box: Use a steel V configuration screed rut box specifically designed and commercially manufactured to fill ruts to perform all Micro Surface, rut-filling applications. Ensure a mixture spread width of 5 to 6 feet and use a secondary strike off to control crown on the rut box. The rutbox must be equipped with a third strike off that may be used to control texture.

420.4.1.4-Miscellaneous Equipment: Provide hand squeegees, shovels and other equipment as necessary to perform the work. Provide cleaning equipment such as power brooms, air compressors, water flushing equipment, and hand brooms for surface preparation.

420.4.1.5-Lights on Equipment: Equip power brooms, distributors and truck mount spreaders with at least one approved, flashing, rotating or oscillating amber light that is visible in all directions. Equip continuous spreader units with one such light on each side.

420.4.2-Application: Micro Surfacing mixtures shall be applied in a manner to fill ruts, minor cracks and leave a uniform surface with straight longitudinal joints, transverse joints and edges.

When performing multiple course Micro Surfacing, the total application rate shall be a minimum of 30 pounds per square yard by weight of dry aggregate with the final surface course not less than 16 pounds per square yard by weight of dry aggregate.

a. Restored Cross-Section: The construction of the leveling course of Micro Surface, Multiple Course will restore the cross section of the driving lane within 1/4 inch as measured transversely across the pavement with a 7-foot straight edge. The preceding will not apply to any pavement segment that is designed with a quarter crown cross slope or any area of the segment within 6 inches of the edge line, lane line, or centerline.
b. Rutfilling: Rutfilling is required when the rut depth is ½ inch or greater and the pay item is Micro Surface. Rutfilling shall use a Micro Surfacing mix with fine aggregate 3FA applied with an approved rut box for each designated wheel track. A clean overlap and straight edges shall be required between wheel tracks. Each pass of rutfilling shall be limited to a maximum depth of 1 inch. For each 1 inch of applied mix, an additional 1/8 inch crown is required for traffic consolidation. All rutfilling material should cure under traffic for at least twenty four (24) hours before additional material is placed.

Micro Surface, Single Course: A single course shall be applied full lane width in one course to the entire pavement surface including the shoulder if indicated in the contract documents at a minimum of 20 pounds per square yard by weight of dry aggregate.

420.4.3-Temporary Pavement Marking: Shall be in accordance with Section 636.

420.4.4-Pre-paving Meeting: Hold an on-site pre-paving meeting with the Engineer before beginning work to review and discuss the following.
   1. Detailed work schedule
   2. Traffic control plan
   3. Calibration of equipment
   4. Mix design previously submitted to the Engineer
   5. Equipment inspection, including transport units

420.4.5-Test strip: Test Strip(s) to demonstrate the mixing of materials and placement procedures of each mixing machine to be used on the project. Test strip shall be performed at the beginning of the first day production and on the roadway to be treated. The completed test strip (minimum 500 feet length) shall be reviewed to detect and correct any variances in surface texture, material ratio(s) and finished surface appearance. Additionally, the test strip will be used to establish the target job application rate.

420.4.6-Surface Preparation: Remove all plastic pavement markings using an abrasion method. Remove markings just before the surfacing operation. Work and payment for removal of pavement markings shall follow Section 636.7 of the Specifications.

Micro Surfacing shall not be placed on top of patches, crack seal, Base Repairs, Edge Repairs, or any other asphalt pavement repairs for at least 14 calendar days. Work and payment for these items shall follow their appropriate sections.

Thoroughly clean the existing surface of all loose materials, vegetation, dirt, dust, mud and other objectionable materials at the time of placing the mixture. Remove animal remains and thoroughly wash the surface before placing the mixture.

The project plans will dictate whether to remove or temporarily cover existing RPMs prior to placement of micro surfacing; payment for removal or covering shall be incidental. When removal is required, the Contractor shall remove RPMs with minimal damage to the pavement surface. Payment for new RPMs shall be in accordance with 663.

Protect drainage structures, monument boxes, water shut-offs, etc., during application of tack coat and mixture.

Apply tack coat according to section 408, except for the following. Mix tack coat with one part emulsion to three parts water. Use the same emulsion as used in the production mixture.
Apply the tack coat uniformly, at an application rate of 0.05-0.12 gallons per square yard and without excessive run off. Allow the tack coat to cure before placement of mixture.

Establish 1,000-foot intervals for the entire project, before placing the mixture. Clearly identify and maintain these intervals until project completion.

420.4.7-**Surface Quality:** Provide a finished surface free from excessive scratch marks, tears, rippling, and other surface irregularities. Do not leave ripples greater than 1/8 inch measured by a 10-foot straight edge. Do not leave tear marks greater than 1/2 inch wide and 4 inches long, or other marks greater than 1 inch wide and 1 inch long. If the finished surface exceeds the described tolerance, stop work immediately and determine appropriate correct action. Review corrective action with the Engineer before resuming production.

Place longitudinal construction joints and lane edges to coincide with the proposed painted lane lines. Construct longitudinal joints with less than 3 inches overlap on adjacent passes and no more than 3/8 inch overlap thickness as measured with a 10-foot straight edge. Place successive passes to prevent ponding of water on the up-slope side of the overlap. Construct neat and uniform transverse joints with less than a 1/8 inch difference in elevation across the joint as measured with a 10-foot straight edge. Provide neat and uniform lane edges with no more than 2 inches of horizontal variance in 100 feet. If defective joints or edges are placed, stop work and take corrective action and reviewed by the Engineer.

420.4.8-**Traffic Control:** Do not allow traffic on the mixture until it has cured sufficiently to prevent pickup by vehicle tires. The new surface must be able to carry normal traffic without damage within one hour of application. Protect the new surface from damage at intersections and driveways. Repair all damage to the mixture caused by traffic. All costs associated with this repair work will be borne by the Contractor. Otherwise Traffic Control will be in accordance with Section 636, and the Manual on Temporary Traffic Control for Streets and Highways, 2006 Edition, or as directed by the Engineer.

420.4.9-**Weather and Seasonal Limitations:**

1. Place the mixture when the air and pavement temperatures are at least 45 °F.
2. Do not place mixture in rain or inclement weather or when temperatures are forecast to be below 32 °F within 24 hours of completion of the work.

420.4.10-**Quality Control:** Produce a mixture that will meet the JMF and the quality control tolerances. Notify the Engineer immediately if the quality control test results exceed any of the tolerances and stop mixture production. Identify the cause of the excess deviation and determine the corrective action necessary to bring the mixture into compliance. Secure the Engineer’s approval before resuming work.
Micro Surfacing Quality Control Tolerances

<table>
<thead>
<tr>
<th>Aggregate Gradation Tolerances (±) from JMF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>Tolerance</td>
</tr>
</tbody>
</table>

General Quality Control Tolerances (±)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement Content Single Test</td>
<td>0.5 % from JMF</td>
<td></td>
</tr>
<tr>
<td>Asphalt Cement Content Daily Average</td>
<td>0.2 % from JMF</td>
<td></td>
</tr>
<tr>
<td>Application Rate:</td>
<td>2 lb/sq yd (as determined by 1000 ft yield checks)</td>
<td></td>
</tr>
<tr>
<td>Sand Equivalent Test (ASTM D2419) (AASHTO M17)</td>
<td>7% from JMF</td>
<td></td>
</tr>
</tbody>
</table>

Verify and document quality control with the following minimum measures:

1. **Fine Aggregate:** Sample from the project stockpile and test for gradation at one test per 500 tons of aggregate or one test per day of mixture production, whichever is greater.

2. **Sand Equivalent Test (ASTM D-2419) (AASHTO M17):** Perform a minimum of one test for each project aggregate stockpile.

3. **Asphalt Content:** At least three times per day, on a random basis, calculate the percent asphalt content of the mixture using the equipment counter readings.

4. **Application Rate:** At least three times per day, on a random basis, calculate the yield of the course being placed using the equipment counter readings.

5. **Documentation:** Complete a daily report that includes the following information. Complete a separate daily report for each truck mounted machine:
   a. Control section, job number, route, Engineer
   b. Date, air temperature
   c. Control settings, calibration values
   d. Unit weight of emulsion (lbs/gal), percent residue in emulsion
   e. Beginning and ending intervals
   f. Counter readings (beginning, ending, and total)
   g. Length, width, total area (sq yd), weight of aggregate, gallons of emulsion
   h. Percent of each material including asphalt cement
   i. Application rate, (lbs/sq yd), combined application rate, (lbs/sq yd)
   j. JMF (percent Portland cement, percent emulsion, gradations, percent asphalt cement)
   k. asphalt cement
   l. Contractor’s authorized signature
   m. Calibration forms
   n. QC aggregate gradations
   o. Aggregate certification
   p. Asphalt emulsion bill of lading
   q. QC sand equivalent test results

For Quality Assurance purposes, samples for gradation will be taken from aggregate stockpiles designated by the Contractor for use. The frequency of sampling and testing will
be established by the Engineer based upon the Department's current acceptance program and local conditions encountered.

420.5- MEASUREMENT AND PAYMENT:

Payment for Micro Surface, Multiple Course includes all materials, equipment, labor for preparing the surface, placing the micro surfacing mixture and complying with all requirements. The placement includes application of a rut-filling and/or leveling course and a surface course for full width coverage as specified in the contract documents.

Payment for Micro Surface, Single Course, includes all materials, equipment, labor for preparing the surface, placing the Micro Surfacing mixture and complying with all requirements. The placement includes application of a single course of mixture for full width coverage as specified in the contract documents.

The completed work as measured will be paid for at the contract unit price for the Items detailed in Section 420.6.

Materials placed in stockpiles or on the road not meeting the required tolerances may be accepted at a reduced price if it is not considered detrimental to the life of the treatment by the Engineer in accordance with ISSA A-143, Section 3. The following price adjustment schedule will be used when appropriate and applied accordingly to representative material:

(i.) One percent reduction in the bid price per square yard for each one-tenth percent the asphalt content is out of tolerance.

(ii.) One-quarter percent price adjustment in the bid price per square yard for each one percent that the aggregate gradation is out of the job mix range.

(iii.) One and a half percent reduction in the bid price per square yard for application rate dropping below the established rate by more than 2 lb/sq yd. If the application rate drops below the established rate by more than 3 lb/sq yd, the material will not be accepted and measures will need to be taken by the contractor to correct for such deficiency.

Price adjustments under 1, 2, and 3 above shall apply concurrently; however, price adjustment will not apply in the event the material is rejected. The disposition of rejected material will be subject to the approval of the Engineer.

420.6-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>420001.*</td>
<td>Micro Surface Multiple Course</td>
<td>Square Yard (Meter)</td>
</tr>
<tr>
<td>420002.*</td>
<td>Micro Surface Single Course</td>
<td>Square Yard (Meter)</td>
</tr>
<tr>
<td>420003.*</td>
<td>Micro Surface Rut Fill</td>
<td>Ton (TN)</td>
</tr>
</tbody>
</table>

*Sequence number
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 716
EMBANKMENT AND SUBGRADE MATERIAL

DELETE SUBSECTION 716.1.1 AND REPLACE WITH THE FOLLOWING:

716.1-GENERAL:
Material for embankment shall be: random material, suitable soil, granular material, shale, rock, random material, hard shale, or borrow material. The material shall have dimension limitations in accordance with the contract documents.

Material for subgrade shall be granular material free of particles larger than 3 inches (75 mm).

716.1.1-Random Material: Random material shall be considered as a mixture of any or all of soil, granular material, or soft shale as described which are permitted by the Engineer to be used in embankment. These are materials that can be incorporated in a 6 inch (150 mm) compacted layer.

716.1.1.1-Soil: Soil material shall be considered as layers or deposits of disintegrated rock, lying on or near the surface of the earth; which has resulted from natural processes, such as weathering, decay or chemical action or a combination of these processes. Material shall be considered as soil when more than 25 percent by weight of the grains or particles pass the No. 200 (75 \( \mu \text{m} \)) sieve.

716.1.1.2-Granular Material: Granular material shall be considered as natural or synthetic mineral aggregate, such as broken or crushed rock, gravel, sand, or slag. Shale or fly ash shall not be considered granular material. Granular material shall have not more than 25 percent by weight of grains or particles passing the No. 200 (75 \( \mu \text{m} \)) sieve (determined by AASHTO T-11 and AASHTO T-27) and the plasticity index shall not be more than 6 (determined by AASHTO T-90). The plasticity index shall be determined using a separate unwashed portion of the field sample. Granular material shall not contain particles larger than 3 inches (75 mm), by visual inspection.

716.1.1.3-Soft Shale: Soft shale shall be considered as any of the shales, weak sandstone, weak limestone, claystones or siltstones that break down using the following roller test. Rock which break down under three complete coverages with a steel drum
roller, meeting the following requirement, shall be classified as soft shale to be placed as specified in 207.7.3.2.1. Smooth drum rollers shall provide a minimum 1.5 tons per linear foot of roller width and drum rollers with any type of feet (sheep’s foot, tamping foot, and etc.) shall provide the same minimum of 1.5 tons per linear foot of roller drum width. This criteria applies to single and multiple drum rollers as well as vibratory rollers with the vibration set to maximum. This criteria shall be calculated for each roller and test combination by dividing the operating weight of the roller in tons by the total measured width of the drum in feet, or the total of all drums if more than one drum. This calculation shall be provided to the Engineer in writing prior to the test. The contractor shall provide the roller or rollers and any other necessary equipment for this test without additional compensation.

716.1.2-Rock: Rock is defined as sandstone, limestone, or concrete that cannot be incorporated in a 6 inch (150 mm) compacted lift and shall be medium hard or harder.

716.1.3-Hard Shale: Material that meets the description of shale in 716.1.1.3 except that is does not break down under the hardness test shall be considered as hard shale and placed as specified in 207.7.3.2.2 when used as embankment material.

716.1.4-Borrow Material: Borrow shall consist of approved material required for the construction of embankments and other portions of the work and shall be subject to the applicable provisions of 211.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS

SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: __________________________

FEDERAL PROJECT NUMBER: __________________________

SECTION 695
MAINLINE PAVEMENT

695.1-DESCRIPTION:

This Special Provision shall define the requirements to construct mainline pavement, which includes roadway pavement and full depth paved shoulders, to the limits as shown by the contract plans. The contractor shall construct one of the pavement systems as described herein and by the contract plans.

**Asphalt Pavement System:**

An asphalt pavement system shall be constructed as defined by the asphalt typical section(s) and all other documents referenced in the contract plans. This work and materials shall include asphalt wearing surface, asphalt base courses, free draining base, fabric for separation, subgrade, and subgrade preparation. The pay items, as shown on the typical section(s) of the contract plans, define the specification for the materials and workmanship only.

**Concrete Pavement System:**

A concrete pavement system shall be constructed as defined by the concrete typical section(s) and all other documents referenced in the contract plans. This work and materials shall include jointed plain concrete pavement, free draining base, fabric for separation, subgrade, and subgrade preparation. The pay items, as shown on the typical section(s) of the contract plans, define the specification for the materials and workmanship only.

695.2-RESTRICTIONS:

The pavement system, selected by the Contractor, shall be the complete system as shown by the typical section(s) in the contract plans. **The Contractor is permitted to submit proposed Quality Control Plans for both pavement systems and select the desired system at a later time.**

The entire “Mainline Pavement System” shall be constructed by a single pavement system. No change in pavement system will be permitted once the paving operation has commenced.
695.3-ADJUSTMENTS:

695.3.1-Material Adjustments:

695.3.1.1-Asphalt Adjustment: This Special Provision shall make use of the latest version of the Standard Specifications, Supplemental Specifications, and applicable Special Provisions for asphalt adjustments, except as described by this special provision.

The proposed Job Mix Formula (JMF) submitted by the contractor, as described in Subsection 401.4.2, shall provide the quantity of asphalt cement, per square yard-inch (SY-IN), for each JMF. The asphalt adjustment shall be based on the lots used for thickness verification. If the pavement section is determined to be less than plan, the ratio of the average thickness to the plan thickness shall be applied to the asphalt cement quantity, for the lot considered for adjustment.

The bidding index (I_b) and the placement index (I_p) may be found posted at the Department Of Transportation’s website Contract Administration’s Lettings page: https://transportation.wv.gov/Highways/Contractadmin/Lettings/Pages/FuelandAsphaltPrices.aspx#AsphaltPrices

695.3.1.2-Cement Adjustment: The compensation for the quantity of Portland cement used in the Concrete Pavement System shall be adjusted based on the latest published price, in dollars per ton, for Portland Cement (Type I) quoted for the average of Cincinnati and Pittsburgh in the Engineering News Record (ENR), Construction Economics Section available at the ENR website: https://www.enr.com/economics using the posted price as published on Wednesday prior to the first day of the month, with the effective date of the index being the first day of the month. If the Wednesday prior to the first day of the month falls on a holiday or the price is otherwise not published for that date the index prices will be based on the next earliest date reported.

The adjustment shall apply regardless of an increase or decrease in the published price as described above. The contract items listed in the Proposal in the Table Of Materials To Be Adjusted For Price Of Portland Cement At The Time Of Placement will be adjusted in accordance with the Division’s indices for Portland Cement.

The placement index (I_p) will be the price in effect for the first day of the month in which the specified adjustable material was actually placed. Both the bidding index (I_b) and the placement index (I_p) will be based on the average of the posted prices described above.

The bidding Portland cement index (I_b) and the placement cement index (I_p) may be found posted at the Department Of Transportation’s website Contract Administration’s Lettings page: http://www.transportation.wv.gov/Highways/Contractadmin/Lettings/Pages/FuelandAsphaltPrices.aspx#CementPrices.

Any dispute concerning the bidding index shall be resolved during the first voucher estimate review.

695.3.1.3-Price Adjustment Formula: The portion of the contract unit price which reflects the cost of the specified material will be adjusted for the change in accordance with the following formula:

\[ Pa = \left[ \frac{I_p}{I_b} - 1 \right] (Q) C \]
Where:

\[ Pa \quad = \quad \text{Price Adjustment} \]
\[ Ip \quad = \quad \text{Price Index at time of placement} \]
\[ Ib \quad = \quad \text{Price Index for Bidding} \]
\[ Q \quad = \quad \text{“As Constructed” Quantity} \]
\[ \quad \text{(converted to CY for Cement Adj.)} \]
\[ \quad \text{(converted to TN for Asphalt Adj.)} \]
\[ C \quad = \quad \text{see below:} \]

\[ C \text{ (asphalt)} = \text{refer to Section 109.10} \]

\[ C \text{ (cement)} = Ib \times (Wc) \times (Tadj) \]

Where:

\[ Ib \quad = \quad \text{Price Index for Bidding} \]
\[ Wc \quad = \quad \text{tons cement per cubic yard from approved mix design} \]
\[ Tadj \quad = \quad \frac{(t_{avg})}{(t_{plan})} \quad \text{as per 695.3.1.3} \]

The price index for determining price adjustments for all work performed after the contract completion date, as revised by approved time extensions, will be determined as follows: The price index (Ip) shall be for the first day of the month in which the contract completion date (as extended), or the price index for first day of the month in which the work was performed, whichever is less.

The quantity of fly ash substitution shall not be included in the quantity eligible for adjustment.

The Portland cement adjustment shall be based on the lots used for thickness verification. If the pavement section is determined to be less than plan, the ratio of the average thickness to the plan thickness shall be applied to the Portland cement quantity, for the lot considered for adjustment.

695.3.2-Smoothness Adjustments: The smoothness for the chosen system of Mainline Pavement shall meet the criteria established in Section 720.

695.3.3-Fuel Adjustments:

695.3.3.1-Subgrade and Free Draining Base: Any fuel adjustment for these items shall be applied directly to the subgrade and free draining base layers of the pavement section as per the table in Section 109.9 of the Standard Specifications. The quantities shall be determined by the cubic yard (CY) calculation that was placed for the respective items in a given month applying the specifications formulas accordingly.

695.3.3.2-Pavement System: The Contractor shall include the unit weight per SY-IN of the pavement system placed (excluding subgrade and free draining base) for the conversion to the Fuel Adjustment as described in Subsection 109.9 Table Of Materials To Be Adjusted And Cost Adjustment Factors For Diesel Fuel Usage. For this adjustment the total square yardage will be the measured quantity accepted and the thickness in inches.
will be based upon the lots as established for thickness verification. If the pavement section is determined to be less than plan, the ratio of the average thickness to the plan thickness shall be applied to the Fuel Adjustment quantity, for the lot considered for adjustment.

695.4-METHOD OF MEASUREMENT:

The quantity of Mainline Pavement to be paid for will be the number of square yards (meters) complete in place and accepted. The width for measurement will be the width of the pavement shown on the surface of the typical cross section of the Plans and additional widening where called for or as otherwise directed in writing by the Engineer. This width shall be verified by field measurements. Widths exceeding the plan dimensions shall not be paid for. The length will be measured on the surface along the centerline of each roadway ramp.

Bridge approach expansion joints will be measured separately and shall be the actual number of joints constructed, complete in place and accepted. Intersection pavement, radius returns, left and right turning lanes (including tapers), will be field verified and paid for at the completion of the project paid for in the last progress payment that includes payment for any additional pavement directed by the Engineer.

Mainline Pavement is to be placed on all side roads up to the edge of the radius return furthest from the edge of mainline traveled way as shown by the detail in the plans.

695.5-BASIS OF PAYMENT:

695.5.1-General: The quantities, determined as provided above, will be paid for at the contract unit prices less adjustments referred to below, which shall constitute full compensation for furnishing all materials as described in the item’s specification and all labor, equipment, tools, field laboratory, supplies and incidentals necessary to complete the work.

695.5.2-Progress Payments: The Progress Payment Schedule shall be based upon the pavement system as shown below. This schedule is intended to compensate the contractor for the material and work accepted.

2 – Lane Roadway \( [L_T = 4 \times \text{project length}] \)  Project Length as defined on title sheet.
4 – Lane Roadway \( [L_T = 8 \times \text{project length}] \)
### 695.5.2.1-Asphalt Pavement System:

<table>
<thead>
<tr>
<th>MATERIAL IN PLACE</th>
<th>VALUE</th>
<th>( \frac{L_p}{L_T} )</th>
<th>Q (SY)</th>
<th>SUBTOTAL (SY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA Mainline Pavement</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Drain. Base</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabric</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgrade Prep.</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Progress Payment</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>(SY)</strong></td>
</tr>
</tbody>
</table>

**Where:**

- \( Q \) = Total Bid Quantity (SY)
- \( L_p \) = Length placed and accepted (Ft)
- \( L_1 \) = A constructed length of asphalt pavement at a thickness of \( t_1 \times L_1 = \text{ft-in} \)
- \( t_1 \) = A proposed thickness of specified lift (in)
- \( L_T \) = Total Lane Lengths (Ft) for the varying widths of different lifts (lanes & shoulders)
- \( t_T \) = Total Pavement Thickness (in) per Typical Section(s)

HMA \( \frac{L_p}{L_T} \) shall be calculated as follows:

\[
\frac{L_1 \ t_1 + L_2 \ t_1 + L_3 \ t_3 \ldots}{L_T \ t_T}
\]

Where 1, 2, 3... Represent the different lifts as shown on the typical section(s)

### 695.5.2.2-Concrete Pavement System:

<table>
<thead>
<tr>
<th>MATERIAL IN PLACE</th>
<th>VALUE</th>
<th>( \frac{L_p}{L_T} )</th>
<th>Q (SY)</th>
<th>SUBTOTAL (SY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PJCP Mainline Pavement</td>
<td>0.72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free Drain. Base</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fabric</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subgrade Prep.</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Progress Payment</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>(SY)</strong></td>
</tr>
</tbody>
</table>

**Where:**

- \( Q \) = Total Bid Quantity (SY)
- \( L_p \) = Length placed and accepted (Ft)
- \( L_1 \) = A constructed length of Cement pavement at a thickness of \( t_1 \times L_1 = \text{ft}^2 \)
- \( t_1 \) = A proposed thickness of specified lift (in)
- \( L_T \) = Total Lane Lengths (Ft) for the varying widths of different lifts (lanes & shoulders)
- \( t_T \) = Total Pavement Thickness (in) per Typical Section(s)

PJCP \( \frac{L_p}{L_T} \) = Length Placed/Length Total
695.6–THICKNESS TESTING:
The measurements which represent the thickness of the sampling units shall be analyzed to determine the average value of the pavement thickness. T=Pavement Thickness, all of the Pavement System above the Free Draining Base. This value will be used to determine the degree of compliance with the provisions set forth in 501.19 and to develop certain factors to be used in the derivation of equitable deductions as set forth in 501.23.1.2 and 501.23.1.3, in the event the provisions of this Specification are not met. **When Scratch Course is called for on the plans, “T” shall be as defined above plus ¼ inch.**

No payment will be made for pavement areas that are 0.922T or less in thickness, the area being defined in the manner set forth in 501.19.2. Pavement which is deficient in thickness by more than 0.7 inches (18 mm) and is considered by the Engineer to be inadequate to perform satisfactorily shall be removed and replaced at no added cost to the Division. The balance of the item, the portion of the item not treated in the manner set forth above, will be treated in the manner set forth in 501.23.1.2 or 501.23.1.3.

695.6.1 - When the average value of the pavement thickness is equal to or greater than the specified thickness, the quantity of pavement represented by this average thickness will be paid at the contract unit price. No additional compensation will be provided for pavement thicknesses greater than as shown by the typical section(s).

695.6.2 - When the average value of the pavement thickness is less than the specified thickness, the fraction of pavement having a thickness greater than the 0.922T will be paid for at a unit price as set forth in the following schedule, and no payment will be made for the remainder of the pavement being considered.

<table>
<thead>
<tr>
<th>Average Value of Pavement Thickness (Inch)</th>
<th>Unit Price as Percent of Contract Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 to 0.10 Less Than Specified Thickness</td>
<td>98.0</td>
</tr>
<tr>
<td>0.11 to 0.20 Less Than Specified Thickness</td>
<td>96.0</td>
</tr>
<tr>
<td>0.21 to 0.30 Less Than Specified Thickness</td>
<td>94.0</td>
</tr>
<tr>
<td>0.31 to 0.40 Less Than Specified Thickness</td>
<td>92.2</td>
</tr>
<tr>
<td>0.41 to 0.50 Less Than Specified Thickness</td>
<td>90.3</td>
</tr>
<tr>
<td>0.51 to 0.60 Less Than Specified Thickness</td>
<td>88.4</td>
</tr>
<tr>
<td>0.61 to 0.70 Less Than Specified Thickness</td>
<td>86.5</td>
</tr>
<tr>
<td>More Than 0.70 Less Than Specified Thickness</td>
<td>0</td>
</tr>
</tbody>
</table>

695.7–PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>695001-002</td>
<td>Mainline Pavement – Asphalt System</td>
<td>Square Yard (Meter)</td>
</tr>
<tr>
<td>695001-003</td>
<td>Mainline Pavement – Concrete System</td>
<td>Square Yard (Meter)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

SECTION 320
AGGREGATE COURSE AND SPEED CONTROL
MOUNDS FOR TRUCK ESCAPE RAMP

320.1-DESCRIPTION:
This work shall consist of the furnishing, spreading and shaping of the aggregate course and speed control mounds on truck escape ramps in accordance with this Specification and in reasonably close conformity with the lines, grades, thicknesses and typical cross sections shown on the Plans or established by the Engineer.

320.2-MATERIALS:
Aggregate shall consist of Ohio River gravel, or other approved stream bed gravel and shall be washed, uncrushed gravel and meet the gradation requirements of Table 320.2A or Table 320.2B. The stone shall conform to the requirements in 703.1.3 and 703.1.4. Total deleterious substances, as described in 703.1.2, shall not be greater than five percent.

| Table 320.2A |
| Amounts Finer Than Each Laboratory Sieve (Square Opening), Percent by Weight |
| 1 ½” (37.5 mm) | 1” (25.0 mm) | ¾” (19.0 mm) | ½” (12.5 mm) | 3/8” (9.5 mm) |
| 100% | 80-100% | 50-70% | 0-20% | 0-5% |

| Table 320.2B |
| Amounts Finer Than Each Laboratory Sieve (Square Opening), Percent by Weight |
| ½” (12.5 mm) | 3/8” (9.5 mm) | No. 4 (4.75 mm) | No. 8 (2.36 mm) | No. 16 (1.18 mm) |
| 100% | 85-100% | 10-30% | 0-10% | 0-5% |

All aggregate will be approved by the Engineer prior to use.
320.3-CONSTRUCTION METHODS:
Prior to the placing of the aggregate on the truck escape ramp, the ramp’s subgrade shall meet the applicable requirements of 207.9 and 228. No aggregate shall be placed when the subgrade is in a wet or frozen condition.

The aggregate shall be placed, spread and shaped on the prepared subgrade in one uncompacted layer. Any machine, combination of machines, or equipment which will handle the material without unduly binding the aggregate together may be used when approved by the Engineer.

The loose thickness of the completed aggregate course, and the shape and dimensions of the constructed speed control-mounds, if any, shall be as shown on the Plans or designated by the Engineer.

320.4-METHOD OF MEASUREMENT:
The quantity of work done under this item will be the number of cubic yards as established in the Proposal. Any additional work beyond the scope of the original plans but authorized by the Engineer will be measured in cubic yards in place and paid at the unit-bid price for the item below, subject, to the provisions of Subsection 104.2 and 109.2.

320.5-BASIS OF PAYMENT:
The quantities, determined as provided above, will be paid for at the contract unit price for the item below, which price and payment shall constitute full compensation for furnishing all the material and doing all the work required to construct the aggregate course and aggregate speed control mounds in a professional and acceptable manner, including labor, tools, equipment, supplies, and incidentals necessary to complete the work.

320.6-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>320001-001</td>
<td>Aggregate for Truck Escape Ramp</td>
<td>Cubic Yard (Meter)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 207

EXCAVATION AND EMBANKMENT

207.2-MATERIALS:
   207.2.2-Sampling and Testing:
   207.2.2.2-Gradation:

   DELETE CONTENTS OF SUBSECTION 207.2.2.2 AND REPLACE WITH THE FOLLOWING:

   207.2.2.2-Gradation: The material shall be sampled and tested in accordance with 207.2.2. Acceptance for gradation shall be on the basis of test results of consecutive random samples from a lot. A sublot is the quantity of material represented by a single gradation test as defined in MP 700.00.06. A lot shall be considered the quantity of material represented by an average test value, not to exceed five sublots. Generally at the beginning of the project, the average shall be started on the second sample in accordance with MP 300.00.51. A sublot is the quantity of material represented by a single gradation test. In the case where only one sample is taken, this sublot shall be considered the lot.

   The average shall start on the second sample result. The average is continued for the third through fifth sample result, averaging all previous sample results. Thereafter, only the last consecutive five sample results will be averaged (i.e., second test value through sixth test value, third test value through seventh test value, and so forth) as defined in MP 300.00.51.

   When the average, or when the most recent three consecutive individual test values of a lot and the test value of the last sublot, or when the last three consecutive individual test values of a lot fall outside the limits specified in 716.1 and 716.1.1.2, the lot of material represented will be considered nonconforming to the extent that the last of its sublots is nonconforming. When this occurs, the last sublot shall have its price adjusted in accordance with Table 207.16.1 207.2.2.3. In the case where the average is nonconforming and the last sublot contained is conforming, there would be no price adjustment. In no event, however, shall a sublot of material have its price adjusted more than once, and the first adjustment, which is determined, shall apply.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 212
STRUCTURE, ROCK AND WET EXCAVATION

212.2-MATERIALS:
  212.2.2-Acceptance Testing:
  212.2.5.2-Gradation:

DELETE CONTENTS OF SUBSECTION 212.2.5.2 AND REPLACE WITH THE FOLLOWING:

  212.2.5.2-Gradation: The material shall be sampled and tested in accordance with 212.2.3. Acceptance for gradation shall be based on test results of consecutive random samples from a lot. A sublot is the quantity of material represented by a single gradation test as defined in MP 700.00.06. A lot shall be considered the quantity of material represented by an average test value, not to exceed five sublots. Generally at the beginning of the project, the average shall be started on the second sample in accordance with MP 300.00.51. A sublot is the quantity of material represented by a single gradation test. In the case where only one sample is taken needed for the total plan quantity, this sublot shall be considered the lot.

  The average shall start on the second sample result. The average is continued for the third through fifth sample result, averaging all previous sample results. Thereafter, only the last consecutive five sample results will be averaged (i.e., second test value through sixth test value, third test value through seventh test value, and so forth) as defined in MP 300.00.51.

  When the average, or when the most recent three consecutive individual test values of a lot and the test value of the last sublot, or when the last three consecutive individual test values of a lot fall outside the limits specified in 212.2, the lot of material represented will be considered nonconforming to the extent that the last of its sublots is nonconforming. When this occurs, the last sublot shall have its price adjusted in accordance with Table 207.16.1 212.2.5.3. In the case where the average is nonconforming and the last sublot contained is conforming, then there would be no price adjustment. In no event, however, shall a sublot of material have its price adjusted more than once, and the first adjustment, which is determined, shall apply.
307.2-MATERIALS:

307.2.4-Acceptance Procedure:

307.2.4.1-Acceptance Plan:

DELETE CONTENTS OF SUBSECTION 307.2.4.1.2 AND REPLACE WITH THE FOLLOWING:

307.2.4.1.2-Gradation: The material shall be sampled and tested in accordance with Section 307.2.3. Acceptance for gradation shall be based on test results of consecutive random samples from a lot. A sublot is the quantity of material represented by a single gradation test as defined in MP 700.00.06. A lot shall be considered the quantity of material represented by an average test value, not to exceed five sublots. In the case where only one sample is needed for the total plan quantity, the sublot shall be considered the lot.

The average shall start on the second sample result. The average is continued for the third through fifth sample result, averaging all previous sample results. Thereafter, only the last consecutive five sample results will be averaged, i.e., second test value through sixth test value, third test value through seventh test value, and so forth as defined in MP 300.00.51.

When the test value of a lot and the test value of the last sublot, or when the last three consecutive individual test values of a lot fall outside the gradation limits of Table 704.6.2A, the lot of material represented will be considered nonconforming to the extent that the last of its sublots are nonconforming. When this occurs, the last sublot shall have its price adjusted in accordance with Table 307.9.1.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 604
PIPE CULVERTS

604.2-MATERIALS:

604.2.4-Acceptance Procedure:

DELETE CONTENTS OF SUBSECTION 604.2.4.2 AND REPLACE WITH THE FOLLOWING:

604.2.4.2-Gradation: The material shall be sampled and tested in accordance with Section 604.2.3. Acceptance for gradation shall be based on test results of consecutive random samples from a lot. A sublot is the quantity of material represented by a single gradation test as defined in MP 700.00.06. A lot shall be considered the quantity of material represented by an average test value, not to exceed five sublots. In the case where only one sample is needed for the total plan quantity, the sublot shall be considered the lot.

The average shall start on the second sample result. The average is continued for the third through fifth sample result, averaging all previous sample results. Thereafter, only the last consecutive five sample results will be averaged, i.e., second test value through sixth test value, third test value through seventh test value, and so forth as defined in MP 300.00.51.

When the test value of a lot and the test value of the last sublot, or when the last three consecutive individual test values of a lot fall outside the gradation limits of Table 704.6.2A the lot of material represented will be considered nonconforming to the extent that the last of its sublots are nonconforming. When this occurs, the last sublot shall have its price adjusted in accordance with Table 604.14.1.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION

FOR

SECTION 609
SIDEWALKS

609.2-MATERIALS:

609.2.5-Acceptance Plan:

DELETE CONTENTS OF SUBSECTION 609.2.5.1 AND REPLACE WITH THE FOLLOWING:

609.2.5.1-Gradation: The material shall be sampled and tested in accordance with Section 609.2.4. Acceptance for gradation shall be based on test results of consecutive random samples from a lot. A sublot is the quantity of material represented by a single gradation test as defined in MP 700.00.06. A lot shall be considered the quantity of material represented by an average test value, not to exceed five sublots. In the case where only one sample is needed for the total plan quantity, the sublot shall be considered the lot.

The average shall start on the second sample result. The average is continued for the third through fifth sample result, averaging all previous sample results. Thereafter, only the last consecutive five sample results will be averaged, i.e., second test value through sixth test value, third test value through seventh test value, and so forth as defined in MP 300.00.51.

When the test value of a lot and the test value of the last sublot, or when the last three consecutive individual test values of a lot fall outside the gradation limits of Table 704.6.2A the lot of material represented will be considered nonconforming to the extent that the last of its sublots are nonconforming. When this occurs, the last sublot shall have its price adjusted in accordance with Table 609.10.1.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 401
ASPHALT BASE, WEARING, AND PATCHING
AND LEVELING COURSES

401.5-TESTING:
401.5.1-Procedures:

DELETE THE TABLE AND REPLACE WITH THE FOLLOWING:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO R 47</td>
<td>Reducing Samples of HMA To Testing Size (Quartering Method)</td>
</tr>
<tr>
<td>AASHTO R 68</td>
<td>Preparation of Asphalt Mixtures by Means of The Marshall Apparatus</td>
</tr>
<tr>
<td>AASHTO T11</td>
<td>Materials Finer Than No. 200 (75 µm) Sieve in Mineral Aggregates by Washing</td>
</tr>
<tr>
<td>AASHTO T27</td>
<td>Sieve Analysis of Fine and Coarse Aggregates</td>
</tr>
<tr>
<td>AASHTO T30</td>
<td>Mechanical Analysis of Extracted Aggregate</td>
</tr>
<tr>
<td>AASHTO T164</td>
<td>Quantitative Extraction of Bitumen from Bituminous Paving Mixtures</td>
</tr>
<tr>
<td>AASHTO T166</td>
<td>Bulk Specific Gravity of Compacted Bituminous Mixtures</td>
</tr>
<tr>
<td>AASHTO T168</td>
<td>Sampling Hot-Mix Asphalt</td>
</tr>
<tr>
<td>AASHTO T209</td>
<td>Maximum Specific Gravity of Bituminous Paving Mixtures</td>
</tr>
<tr>
<td>AASHTO T308</td>
<td>Asphalt Content of HMA By the Ignition Method (Test Method A)</td>
</tr>
<tr>
<td>AASHTO T312</td>
<td>Determining the Density of HMA Specimens by Means of The Superpave Gyratory Compactor</td>
</tr>
<tr>
<td>AASHTO T355</td>
<td>Standard Method of Test for In-Place Density of Asphalt Mixtures by Nuclear Methods</td>
</tr>
<tr>
<td>MP 700.00.06</td>
<td>Aggregate Sampling Procedures</td>
</tr>
</tbody>
</table>
401.6-CONTRACTORS QUALITY CONTROL:

ADD THE FOLLOWING SUBSECTION:

401.6.4-Compaction: Projects shall be tested for compaction in accordance with the Lot-by-Lot test method described in Section 401.6.4.2 if the project limits meet all four of the following requirements:

1. Measured roadway width greater than 16 feet
2. Total design overlay thickness of pavement greater than or equal to 1.5 inches.
3. Total average daily traffic (ADT) greater than 500.
4. Total projects length greater than or equal to 0.5 miles, excluding skip paving.

If a project does not meet the above criteria, testing for compaction shall be in accordance with the Rollerpass test method described in Section 401.6.4.2.

In addition, areas of Trench Paving, Pavement Widening, and Pavement Repairs shall be tested in accordance with the Rollerpass test method or to the satisfaction of the Engineer.

When asphalt is placed in areas that require a non-uniform thickness and tapers to a thin edge including patch and level and scratch, acceptance testing of the material is not required.

Compaction shall be accomplished with a minimum of eight (8) roller passes prior to reaching the temperature specified in section 401.10.4. A pass shall be defined as the entire roller traversing a spot on the pavement. Compaction shall be performed by a three-wheel (steel) roller or pneumatic-tire roller.

Acceptance testing is not required on areas which are too narrow to be compacted with the roller use for the mainline paving, as defined in the contractor’s QC plan; such areas shall be compacted to the satisfaction of the Engineer. When asphalt is placed in areas that require a non-uniform thickness or is tapered to a thin edge, the method of acceptance testing will be determined by the Engineer. Acceptance testing is not required on areas in which a roller, as defined in the contractor’s QC plan, is restricted from properly compacting the mat; these areas shall be compacted to the satisfaction of the Engineer.

401.6.4.1-Density Testing: All Gauge standardization procedures, calibration procedures and all Density testing conducted shall be in accordance with AASHTO T 355 - Standard Method of Test for In-Place Density of Asphalt Mixtures by Nuclear Methods. Testing shall be conducted in the Backscatter Alternate Method no. 1 180 degree Rotation position and follow the AASHTO Procedure with the exception that no gauge rotation will be required. All gauge tests shall be conducted with the source end of the gauge in the direction of paving. The Gauges used for both QC and QA, shall also have a gauge comparison tested as prescribed in MP 401.05.20 section 401.6.4.1.1.

401.6.4.1.1-Gauge Comparison: For purposes of an accurate comparison, nuclear gauges used for QC and QA shall be compared using the following procedure.

1. The gauge used for the Contractor’s quality control testing should be compared with the gauge used for the Division’s verification testing.
2. Standardize both gauges according to AASHTO T 355.
3. Place the aluminum plate provided by the Division on the standard block used for
verification testing. Place the standard block on material weighing a minimum of 110 lb/ft³ (1762 kg/m³). The block must not be near metal or other objects during testing and must not be moved. Keep the gauges separated a minimum of 30 feet (9.1 meters) during testing.

4. Take five (5) one-minute wet density readings with each gauge in the backscatter position. The gauges are to be oriented on the block the same as for standardization.

5. Record the wet density readings exactly as shown on the gauge. The range of the five readings shall not exceed 1.5 lb/ft³ (24 kg/m³). If the readings exceed this range, perform a new set of five readings. A gauge should not be used if the repeatability of the gauge is not within this range.

6. Average the five readings for each gauge. The gauges are considered similar if the averages of the readings are within 3 lb/ft³ (48 kg/m³).

7. The density readings for verification testing will not be adjusted to compensate for any differences in readings between gauges.

401.6.4.1.2- Thin Lift Correction: A Thin Lift Correction shall be performed on the existing pavement layer, in the state at which it will be paved. Density readings for the Correction shall be taken prior to paving. The correction shall be calculated as described in the operations manual of the testing device. The Thin Lift Correction shall be established as described below:

Lot-By-Lot: Five randomly located tests within the initial 1500 feet. The average of the five tests shall be used as the underlying density in the correction equation. These values shall be recorded on the thin lift correction testing form. A new thin lift correction shall be completed if the existing pavement changes, e.g. milled, unmilled, scratch, concrete.

Rollerpass: Five randomly located tests within the initial area of paving for the day or wherever a new Rollerpass is to be established. These five tests shall be conducted within a 400-foot section, the average shall be used as the underlying density in the correction equation. These values shall be recorded on the thin lift correction testing form. This section shall begin 100 feet beyond the transverse joint, or immediately when a new Rollerpass is to be conducted. Randomly located tests within the initial area of paving for the day or wherever a new rollerpass is to be established. This shall consist of five randomly located tests within a 1500 foot section. The average of the five tests shall be used as the underlying density in the correction equation. These values shall be recorded on the thin lift correction testing form.

401.6.4.2- Lot-by-Lot Testing: Density of the traveled lanes, shoulders, and Longitudinal Joint will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot shall consist of five equal sublots. Sublots shall be tested with randomly located nuclear density tests, tests shall utilize the Thin Lift Correction as described in 401.6.4.1.24. A normal lot size shall not exceed 1500 linear feet of paving with five, 300 linear foot sublots, unless operational conditions or project size dictates otherwise. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reason to adjust the lot size. The original lot will be continued when work resumes. Relative density shall be
calculated based on the Maximum Specific gravity from the Division approved JMF or the Maximum Specific Gravity established under section 401.6.2, Job Mix Formula Verification, whichever is more recently established.

401.6.4.1-Mat Density: Compaction testing for the mat density shall be performed for all traveled lanes and shoulders and will be evaluated based on an Upper Specification Limit (USL) of 976.0% relative density and a Lower Specification Limit (LSL) of 92.0% relative density. The average mat density of the Lot shall be calculated as the average of the sublot results. Acceptance of Mat Density shall be in accordance with Section 401.13.3.

401.6.4.2-Joint Density: Longitudinal Joint Density testing shall be performed on all constructed joints between traveled lanes. A Longitudinal Joint constructed between a travel lane and a shoulder will not require testing. Joint density testing is not required until both lanes of the joint are constructed. The first lane constructed shall be referred to as the cold side and the second lane shall be referred to as the hot side. Joint density testing shall be conducted on the hot side, with the gauge positioned four inches from the constructed joint.

Longitudinal Joint Density testing shall be accepted in the field on a lot by lot basis as described in Section 401.6.4.1. Compaction testing for the Joint density will be evaluated based on an Upper Specification Limit (USL) of 976.0% relative density and a Lower Specification Limit (LSL) of 90.0% relative density. The average Joint density of the Lot shall be calculated as the average of the sublot results. Acceptance of Joint density shall be in accordance with Section 401.13.3.

401.6.4.3-Roller Pass Testing:
A Rollerpass compaction Control Section shall be completed on a daily basis, when roadway conditions change where they would affect the compaction effort, or when the Engineer determines the current rollerpass is unsatisfactory. The Rollerpass shall be established prior to the mat reaching the temperature specified in section 401.10.4 temperature reaching 17F and shall be conducted in the following manner:

1. The Control Rollerpass section shall be conducted within the first 100 feet beyond the initial transverse construction joint, or immediately when a new Rollerpass is to be conducted. Follow section 401.6.4.1.2 to establish a Thin Lift correction factor.
2. Apply four passes (a pass shall be defined as the entire roller traversing a spot on the pavement) to the roadway, then conduct two randomly located two nuclear density testing within on the section; record the results, the average, and the mat temperature at each test location.
3. Apply an additional two passes and repeat the nuclear density testing in the same locations; record the results, the average, and the mat temperature at each test location.
4. Repeat step 3 until one of the following conditions occur: less than 5 kg/m³ increase occurs between the average of two sets of readings, the density of the material exceeds 97.0% Gmm, or one test location “breaks over” (i.e., shows a decrease in density) after exceeding 92.0% Gmm (i.e., shows a decrease in density).
5. Compute the Percent of Gmm using the thin lift correction.

Once the control section is completed, the Thin Lift corrected density shall be equal to or greater than 92.0% Gmm using the Thin Lift correction. If the measured density does not meet 92%, compact the material to the satisfaction of the engineer. Once the number of roller passes is established conduct a proving section in the next 200'. If the thin lift corrected density does not meet 92%, repeat the procedure above immediately. If after two the density still does not meet 92% Gmm, contractor shall apply the number of passes associated with the highest percent density.

If the thin lift corrected density meet 92% Gmm conduct a proving section in the proceeding 200 feet. Within this proving section, apply the established number of passes and conduct shall be tested with five ten randomly located nuclear density tests, once the established number of passes is complete. The average of these five ten tests shall be within 1.5% of the average wet density determined in the Rollerpass control section. If this is not achieved a new test section shall be conducted.

All data shall be submitted the Engineer on associated Rollerpass forms.

401.7-ACCEPTANCE TESTING:

DELETE SUBSECTION 401.7 TITLE AND REPLACE WITH THE FOLLOWING:

401.7-VERIFICATION TESTING:

DELETE SUBSECTION 401.7.3 AND REPLACE WITH THE FOLLOWING:

401.7.3-Lot by Lot Compaction: Verification testing of mat and joint density is the responsibility of the Division. The division will conduct density verification testing in accordance with section 401.6.4.1. Verification activities will be accomplished by conducting testing completely independent of the quality control activities. Tests will be taken at a frequency approximately equal to one two lots per fiveeight for both mat and joint density, with a minimum of one two lot evaluation for each Mat and Joint per project. If a Joint density lot is to be tested, it will be tested with the corresponding Mat lot.

401.7.3.1-Evaluation for Similarity: The ten (10) verification tests taken by the Division will be statistically evaluated, using an F-test and T-test at a 95% confidence level, for statistical similarity to the Contractors ten (10) quality control tests. If the evaluation indicates that the Division’s test results are statistically similar to the Contractor’s test results, then the test results represented by this evaluation will be considered acceptable, therefore shall be used in the price adjustment in accordance with section 401.13.3.

If the evaluation proves statistically not similar an investigation will be conducted to determine the cause and extent of nonsimilarity. The intent of the investigation is to define and correct any testing deficiencies that may cause a misrepresentation of the tested material. In addition, if the evaluation is statistically not similar, the DDOH Division may test additional lots and use the verification testing results for the basis of payment.

401.13-BASIS OF PAYMENT:
401.13.3–Basis of Payment: When a Lot of asphalt pavement shall have its price be adjusted does not meet the density requirements of 401.6.4, the price shall be adjusted in accordance with Table 401.13.3A using Formula-1. If a Lot of asphalt pavement is associated with a Longitudinal joint Lot its price shall be adjusted in accordance with Table 401.13.3A and Table 401.13.3B using Formula-2. For projects that require longitudinal joint density testing, then Table 401.13.3B shall also be used to determine any price adjustment for nonconforming joint density test results. The longitudinal joint density determined in accordance with Section 401.6.4 shall represent the Lot on which the joint density testing was performed. Any price adjustment for joint density shall be applied to that Lot only.

Use Formula-1 on the first lane paved before a longitudinal joint is constructed. Use Formula-2 when both mat and joint density testing is required on a project.

**FORMULA-1:** Lots requiring only mat density testing:

\[
\text{Lot Price Adjustment (Mat only)} = (\text{unit price}) \times (\text{Lot quantity}) \times (\text{mat density price adjustment }\% \text{ from Table 401.13.3A})
\]

**FORMULA-2:** Lots requiring both mat and joint density testing:

\[
\text{Lot Price Adjustment (Mat + Joint)} = (\text{unit price}) \times (\text{Lot quantity}) \times [(\text{mat density price adjustment }\% \text{ from Table 401.13.3A}) + (\text{joint density price adjustment }\% \text{ from Table 401.13.3B})]
\]

<table>
<thead>
<tr>
<th>TABLE 401.13.3A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustment of Contract Price for Pavement Mat Density</td>
</tr>
<tr>
<td>Percent of Density</td>
</tr>
<tr>
<td>Greater than 97.6%</td>
</tr>
<tr>
<td>95% to 97.6%</td>
</tr>
<tr>
<td>92% to 94%</td>
</tr>
<tr>
<td>91-88</td>
</tr>
<tr>
<td>Less than 88%</td>
</tr>
</tbody>
</table>
TABLE 401.13.3A
Adjustment of Contract Price for Pavement Mat Density

<table>
<thead>
<tr>
<th>Percent of Density</th>
<th>Percent of Contract Price to be Paid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note 2: When the density is less than 92%, the mat will be more susceptible to accelerated deterioration and a decrease in the expected service life of the pavement. For mat densities less than 88%, the percent of Contract Bid Price will be decreased by an additional 10% per percentage of mat density less than 88%, unless a Special evaluation performed by the Division determines a more appropriate action.</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 401.13.3B
Adjustment of Contract Price for Pavement Joint Density

<table>
<thead>
<tr>
<th>Percent of Joint Density</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 967 %</td>
<td>Note 3</td>
</tr>
<tr>
<td>945 % to 967 %</td>
<td>+2.0%</td>
</tr>
<tr>
<td>92% to 934%</td>
<td>+1.0</td>
</tr>
<tr>
<td>90% to 91% Note 4</td>
<td>0%</td>
</tr>
<tr>
<td>89 % Note 5a</td>
<td>-1.0%</td>
</tr>
</tbody>
</table>

Note 3: Density greater than 976% is normally only a problem if it leads to asphalt flushing on the surface of the mat or rutting due to an unstable mix. The Division will make a special evaluation of the material and determine the appropriate action.

Note 4: If the longitudinal joint density is determined to be less than 92% on at least 205% of the total project LOTs, then the Contractor shall be required to seal the joint a minimum of 3” on each side of the joint with a heated PG 64S-22 binder (or approved equivalent) on the entire project at no additional cost to the Division.

Note 5: Any longitudinal joint densities determined to be below 90% the Contractor shall be required to seal the joint a minimum of 3” on each side of the joint on the entire project with a heated PG 64S-22 binder (or approved equivalent) at no additional cost to the Division.

Note 6: Density values less than the minimum specified 90% will be more susceptible to accelerated deterioration of both the joint and the surrounding pavement. For joint densities less than 88%, the percent of adjustment will be decreased by an additional 10% per percentage of joint density less than 88%, unless a Special evaluation performed by the Division determines a more appropriate action.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 401

ASPHALT BASE, WEARING, AND PATCHING
AND LEVELING COURSES

401.5-TESTING:
401.5.1-Procedures:

DELETE THE TABLE AND REPLACE WITH THE FOLLOWING:

<table>
<thead>
<tr>
<th>AASHTO</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R 47</td>
<td>Reducing Samples of HMA To Testing Size (Quartering Method)</td>
</tr>
<tr>
<td>R 68</td>
<td>Preparation of Asphalt Mixtures by Means of The Marshall Apparatus</td>
</tr>
<tr>
<td>T11</td>
<td>Materials Finer Than No. 200 (75 µm) Sieve in Mineral Aggregates by Washing</td>
</tr>
<tr>
<td>T27</td>
<td>Sieve Analysis of Fine and Coarse Aggregates</td>
</tr>
<tr>
<td>T30</td>
<td>Mechanical Analysis of Extracted Aggregate</td>
</tr>
<tr>
<td>T164</td>
<td>Quantitative Extraction of Bitumen from Bituminous Paving Mixtures</td>
</tr>
<tr>
<td>T166</td>
<td>Bulk Specific Gravity of Compacted Bituminous Mixtures</td>
</tr>
<tr>
<td>T168</td>
<td>Sampling Hot-Mix Asphalt</td>
</tr>
<tr>
<td>T209</td>
<td>Maximum Specific Gravity of Bituminous Paving Mixtures</td>
</tr>
<tr>
<td>T308</td>
<td>Asphalt Content of HMA By the Ignition Method (Test Method A)</td>
</tr>
<tr>
<td>T312</td>
<td>Determining the Density of HMA Specimens by Means of The Superpave Gyratory Compactor</td>
</tr>
<tr>
<td>T355</td>
<td>Standard Method of Test for In-Place Density of Asphalt Mixtures by Nuclear Methods</td>
</tr>
<tr>
<td>700</td>
<td>Aggregate Sampling Procedures</td>
</tr>
</tbody>
</table>
401.6-CONTRACTORS QUALITY CONTROL:

ADD THE FOLLOWING SUBSECTION:

401.6.4-Compaction: Projects shall be tested for compaction in accordance with the Lot-by-Lot test method described in Section 401.6.4.2 if the project limits meet all four of the following requirements:

1. Measured roadway width greater than 16 feet
2. Total design overlay thickness of pavement greater than or equal to 1.5 inches.
3. Total average daily traffic (ADT) greater than 500.
4. Total projects length greater than or equal to 0.5 miles, excluding skip paving.

If a project does not meet the above criteria, testing for compaction shall be in accordance with the Rollerpass test method described in Section 401.6.4.2.

In addition, areas of Trench Paving, Pavement Widening, and Pavement Repairs shall be tested in accordance with the Rollerpass test method or to the satisfaction of the Engineer.

When asphalt is placed in areas that require a non-uniform thickness and tapers to a thin edge including patch and level and scratch, acceptance testing of the material is not required.

Compaction shall be accomplished with a minimum of eight (8) roller passes prior to reaching the temperature specified in section 401.10.4. A pass shall be defined as the entire roller traversing a spot on the pavement. Compaction shall be performed by a three-wheel (steel) roller or pneumatic-tire roller.

Acceptance testing is not required on areas which are too narrow to be compacted with the roller use for the mainline paving, as defined in the contractor’s QC plan; such areas shall be compacted to the satisfaction of the Engineer.

401.6.4.1-Density Testing: All Gauge standardization procedures, calibration procedures and all Density testing conducted shall be in accordance with AASHTO T 355 - Standard Method of Test for In-Place Density of Asphalt Mixtures by Nuclear Methods. Testing shall be conducted in the backscatter position and follow the AASHTO Procedure with the exception that no gauge rotation will be required. All gauge tests shall be conducted with the source end of the gauge in the direction of paving. The Gauges used for both QC and QA, shall also have a gauge comparison tested as prescribed in section 401.6.4.1.1.

401.6.4.1.1-Gauge Comparison: For purposes of an accurate comparison, nuclear gauges used for QC and QA shall be compared using the following procedure.

1. The gauge used for the Contractor’s quality control testing should be compared with the gauge used for the Division’s verification testing.
2. Standardize both gauges according to AASHTO T 355.
3. Place the aluminum plate provided by the Division on the standard block used for verification testing. Place the standard block on material weighing a minimum of 110lb/ft³ (1762 kg/m³). The block must not be near metal or other objects during testing and must not be moved. Keep the gauges separated a minimum of 30 feet (9.1 meters) during testing.
4. Take five (5) one-minute wet density readings with each gauge in the backscatter
position. The gauges are to be oriented on the block the same as for standardization.

5. Record the wet density readings exactly as shown on the gauge. The range of the five readings shall not exceed 1.5 lb/ft\(^3\) (24 kg/m\(^3\)). If the readings exceed this range, perform a new set of five readings. A gauge should not be used if the repeatability of the gauge is not within this range.

6. Average the five readings for each gauge. The gauges are considered similar if the averages of the readings are within 3 lb/ft\(^3\) (48 kg/m\(^3\)).

7. The density readings for verification testing will not be adjusted to compensate for any differences in readings between gauges.

401.6.4.1.2-Thin Lift Correction: A Thin Lift Correction shall be performed on the existing pavement layer, in the state at which it will be paved. Density readings for the Correction shall be taken prior to paving. The correction shall be calculated as described in the operations manual of the testing device. The Thin Lift Correction shall be established as described below:

   **Lot-By-Lot:** Ten randomly located tests within the initial 1500 feet. The average of the ten tests shall be used as the underlying density in the correction equation. These values shall be recorded on the thin lift correction testing form. A new thin lift correction shall be completed if the existing pavement changes, e.g. milled, unmilled, scratch, concrete.

   **Rollerpass:** Five randomly located tests within the initial area of paving for the day or wherever a new Rollerpass is to be established. These five tests shall be conducted within a 400-foot section, the average shall be used as the underlying density in the correction equation. These values shall be recorded on the thin lift correction testing form. This section shall begin 100 feet beyond the transverse joint, or immediately when a new Rollerpass is to be conducted.

401.6.4.2-Lot-by-Lot Testing: Density of the traveled lanes, shoulders, and Longitudinal Joint will be accepted in the field on a lot by lot basis. Lots will be established cumulatively and will be specific for each JMF. Each lot shall consist of five equal sublots. Sublots shall be tested with randomly located nuclear density tests, tests shall utilize the Thin Lift Correction as described in 401.6.4.1.2. A normal lot size shall not exceed 1500 linear feet of paving with five, 300 linear foot sublots, unless operational conditions or project size dictates otherwise. Breakdowns or stoppages of short periods due to such causes as weather or equipment failure will not be considered as reason to adjust the lot size. The original lot will be continued when work resumes. Relative density shall be calculated based on the Maximum Specific gravity from the Division approved JMF or the Maximum Specific Gravity established under section 401.6.2, Job Mix Formula Verification, whichever is more recently established.

401.6.4.2.1-Mat Density: Compaction testing for the mat density shall be performed for all traveled lanes and shoulders and will be evaluated based on an Upper Specification Limit(USL) of 97.0% relative density and a Lower Specification Limit(LSL) of 92.0% relative density. The average mat density of the Lot shall be calculated as the average of the sublot results. Acceptance of Mat Density shall be in accordance with Section 401.13.3.
401.6.4.2.2-Joint Density: Longitudinal Joint Density testing shall be performed on all constructed joints between traveled lanes. A Longitudinal Joints constructed between a travel lane and a shoulder will not require testing. Joint density testing is not required until both lanes of the joint are constructed. The first lane constructed shall be referred to as the cold side and the second lane shall be referred to as the hot side. Joint density testing shall be conducted on the hot side, with the gauge positioned four inches from the constructed joint.

Longitudinal Joint Density testing shall be accepted in the field on a lot by lot basis as described in Section 401.6.4.1. Compaction testing for the Joint density will be evaluated based on an Upper Specification Limit (USL) of 97.0% relative density and a Lower Specification Limit (LSL) of 90.0% relative density. The average Joint density of the Lot shall be calculated as the average of the sublot results. Acceptance of Joint density shall be in accordance with Section 401.13.3.

401.6.4.3-Roller Pass Testing: A Rollerpass Control Section shall be completed on a daily basis, when roadway conditions change where they would affect the compaction effort, or when the Engineer determines the current rollerpass is unsatisfactory. The Rollerpass shall be established prior to the mat reaching the temperature specified in section 401.10.4 and shall be conducted in the following manor:

1. The Control Rollerpass section shall be conducted within the first 100 feet beyond the initial transverse construction joint, or immediately when a new Rollerpass is to be conducted. Follow section 401.6.4.1.2 to establish a Thin Lift correction factor.
2. Apply four passes (a pass shall be defined as the entire roller traversing a spot on the pavement) to the roadway, then conduct two randomly located nuclear density testing within the section; record the results, the average, and the mat temperature at each test location.
3. Apply an additional two passes and repeat the nuclear density testing in the same locations; record the results, the average, and the mat temperature at each test location.
4. Repeat step 3 until one of the following conditions occur: less than 5 kg/m$^3$ increase occurs between the average of two sets of readings, the density of the material exceeds 97.0% Gmm, or one test location “breaks over” (i.e. shows a decrease in density) after exceeding 92.0% Gmm.
5. Compute the Percent of Gmm using the thin lift correction.

Once the control section is completed, the Thin Lift corrected density shall be equal to or greater than 92.0% Gmm. If the thin lift corrected density does not meet 92%, repeat the procedure above immediately. If after two the density still does not meet 92% Gmm, contractor shall apply the number of passes associated with the highest percent density.

If the thin lift corrected density meet 92% Gmm conduct a proving section in the proceeding 200 feet. Within the proving section, apply the established number of passes and conduct ten randomly located nuclear density tests. The average of these ten tests shall be within 1.5% of the average wet density determined in the Rollerpass control section. If this is not achieved a new test section shall be conducted. All data shall be submitted the
Engineer on associated Rollerpass forms.

401.7-ACCEPTANCE TESTING:

DELETE SUBSECTION 401.7 TITLE AND REPLACE WITH THE FOLLOWING:

401.7-VERIFICATION TESTING:

DELETE SUBSECTION 401.7.3 AND REPLACE WITH THE FOLLOWING:

401.7.3-Lot by Lot Compaction: Verification testing of mat and joint density is the responsibility of the Division. The division will conduct density verification testing in accordance with section 401.6.4.1. Verification activities will be accomplished by conducting testing completely independent of the quality control activities. Tests will be taken at a frequency approximately equal to two lots per eight for both mat and joint density, with a minimum of two lot evaluation for each Mat and Joint per project. If a Joint density lot is to be tested, it will be tested with the corresponding Mat lot.

401.7.3.1-Evaluation for Similarity: The ten (10) verification tests taken by the Division will be statistically evaluated, using an F-test and T-test at a 95% confidence level, for statistical similarity to the Contractors ten (10) quality control tests. If the evaluation indicates that the Division’s test results are statistically similar to the Contractor’s test results, then the test results represented by this evaluation will be considered acceptable, therefore shall be used in the price adjustment in accordance with section 401.13.3. If the evaluation proves statistically not similar an investigation will be conducted to determine the cause and extent of non-similarity. The intent of the investigation is to define and correct any testing deficiencies that may cause a misrepresentation of the tested material. In addition, if the evaluation is statistically not similar, the Division may test additional lots and use the verification testing results for the basis of payment.

401.13-BASIS OF PAYMENT:

401.13.3-Basis of Payment: A Lot of asphalt pavement shall have its price be adjusted in accordance with Table 401.13.3A using Formula-1. If a Lot of asphalt pavement is associated with a Longitudinal joint Lot its price shall be adjusted in accordance with Table 401.13.3A and Table 401.13.3B using Formula-2. The longitudinal joint density determined in accordance with Section 401.6.4 shall represent the Lot on which the joint density testing was performed. Any price adjustment for joint density shall be applied to that Lot only.

Use Formula-1 on the first lane paved before a longitudinal joint is constructed. Use Formula-2 when both mat and joint density testing is required on a project.

**FORMULA-1:** Lots requiring only mat density testing:

Lot Price Adjustment (Mat only) = (unit price) X (Lot quantity) X (mat density price adjustment % from Table 401.13.3A)
FORMULA-2: Lots requiring both mat and joint density testing:

Lot Price Adjustment (Mat + Joint) = (unit price) X (Lot quantity) X [(mat density price adjustment % from Table 401.13.3A) + (joint density price adjustment % from Table 401.13.3B)]

**TABLE 401.13.3A**
Adjustment of Contract Price for Pavement Mat Density

<table>
<thead>
<tr>
<th>Percent of Density</th>
<th>Percent of Contract Price to be Paid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 97%</td>
<td>Note 1</td>
</tr>
<tr>
<td>95% to 97%</td>
<td>102</td>
</tr>
<tr>
<td>92% to 94%</td>
<td>100</td>
</tr>
<tr>
<td>91-88</td>
<td>= 100 – 4*(92% - Percent density)</td>
</tr>
<tr>
<td>Less than 88%</td>
<td>= 84 – 10*(88% - Percent density)</td>
</tr>
</tbody>
</table>

Note 1: Mat density slightly above 97% is normally only a problem if it leads to asphalt flushing on the surface of the mat or rutting due to an unstable mix. The Division will make a special evaluation of the material and determine the appropriate action.

Note 2: When the density is less than 92%, the mat will be more susceptible to accelerated deterioration and a decrease in the expected service life of the pavement. For mat densities less than 88%, the percent of Contract Bid Price will be decreased by an additional 10% per percentage of mat density less than 88%, unless a Special evaluation performed by the Division determines a more appropriate action.

**TABLE 401.13.3B**
Adjustment of Contract Price for Pavement Joint Density

<table>
<thead>
<tr>
<th>Percent of Joint Density</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 97 %</td>
<td>Note 3</td>
</tr>
<tr>
<td>94 % to 97 %</td>
<td>+2.0%</td>
</tr>
<tr>
<td>92% to 93%</td>
<td>+1.0</td>
</tr>
<tr>
<td>90% to 91% Note 4</td>
<td>0%</td>
</tr>
<tr>
<td>89 % Note 5</td>
<td>-1.0%</td>
</tr>
</tbody>
</table>

Note 3: Density greater than 97% is normally only a problem if it leads to asphalt flushing on the surface of the mat or rutting due to an unstable mix. The Division will make a special evaluation of the material and determine the appropriate action.
## TABLE 401.13.3B
Adjustment of Contract Price for Pavement Joint Density

<table>
<thead>
<tr>
<th>Percent of Joint Density</th>
<th>Percent Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Note 4:</strong> If the longitudinal joint density is determined to be less than 92% on at least 25% of the total project LOTs, then the Contractor shall be required to seal the joint a minimum of 3” on each side of the joint with a heated PG 64S-22 binder (or approved equivalent) on the entire project at no additional cost to the Division.</td>
<td></td>
</tr>
<tr>
<td><strong>Note 5:</strong> Any longitudinal joint densities determined to be below 90% the Contractor shall be required to seal the joint a minimum of 3” on each side of the joint on the entire project with a heated PG 64S-22 binder (or approved equivalent) at no additional cost to the Division.</td>
<td></td>
</tr>
<tr>
<td><strong>Note 6:</strong> Density values less than the minimum specified 90% will be more susceptible to accelerated deterioration of both the joint and the surrounding pavement. For Joint densities less than 88%, the percent of adjustment will be decreased by an additional 10% per percentage of joint density less than 88%, unless a Special evaluation performed by the Division determines a more appropriate action.</td>
<td></td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 607
GUARDRAIL

607.1-DESCRIPTION:
This work shall consist of the construction or reconstruction of guardrail in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans or established by the Engineer.
The types of guardrail are designated as follows:

Type 1, Galvanized Steel Deep Beam Type Guardrail or Zinc-Aluminum-Magnesium Alloy-Coated Steel Deep Beam Type Guardrail
Type 2, Blank
Type 3, Blank
Type 4, Blank
Type 5, Galvanized Steel Double-Faced Guardrail (Deep Beam Type) or Zinc-Aluminum-Magnesium Alloy-Coated Steel Double-Faced Guardrail (Deep Beam Type)

All installations of Type 1 & 5 Guardrail will be classified according to one of the designations specified. The guardrail class will be indicated in the pay items and on the Plans,

Class I: 6 feet - 3 inches (1905 mm) post spacing with blocks
Class II: 12 feet - 6 inches (3810 mm) post spacing with blocks
Class III: 12 feet - 6 inches (3810 mm) post spacing without blocks.
Class IV: 3 ft. 1½ in. (952 mm) post spacing without blocks.
Class V: 3 ft. 1½ in. (952 mm) post spacing with blocks.

The construction of the guardrail shall include the complete furnishing, assembling and erecting of all component parts and materials at the location shown on the Plans or directed by the Engineer.

A Modified Cut Slope Terminal shall consist of supplying and installing additional length guardrail posts, an additional W-beam guardrail section (bottom beam), and standard guardrail cut slope terminal components.

Tangent End Terminal Repair and Flared End Terminal Repair shall consist of carefully removing, and replacing the damaged components of the End Treatments. All components of the end treatment system shall be replaced with the respective manufacturer’s parts and are to conform.
to the original design of the system as outlined in the Standard Details Volume I and the manufacture's design.

607.2-MATERIALS:
Materials shall meet the requirements of the following Subsections of Division 700:

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>SUBSECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete for Footers</td>
<td>715.12</td>
</tr>
<tr>
<td>Galvanized Steel Deep Beam Type Guardrail</td>
<td>712.4</td>
</tr>
<tr>
<td>Fasteners and Anchor Bolts</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous Concrete</td>
<td>715.12</td>
</tr>
<tr>
<td>Offset Blocks</td>
<td>710.3, 710.5 *</td>
</tr>
<tr>
<td>Pressure Treated Wood Guardrail Posts</td>
<td>710.3, 710.5</td>
</tr>
<tr>
<td>Retroreflective Sheeting for Traffic Control</td>
<td>715.9.2.8</td>
</tr>
<tr>
<td>Steel Guardrail Posts</td>
<td>709.45</td>
</tr>
<tr>
<td>Zinc-Aluminum-Magnesium Alloy-Coated Steel Deep Beam Type Guardrail</td>
<td>712.5</td>
</tr>
<tr>
<td>Zinc Rich Primer (Galvanized Repair)</td>
<td>711.21</td>
</tr>
</tbody>
</table>

* Other material types may be substituted from the division’s approved list.

All materials must be protected from damage during storage and handling. All materials, including materials which have been approved previously, will be subject to inspection by the Engineer as to condition at any time prior to or during incorporation of the material in the work. Materials which have been damaged shall not be used.

CONSTRUCTION METHODS

607.3-SETTING POSTS AND PLACING FOOTERS:

607.3.1-General: Unless one type is specified, posts may be of steel, or wood, and the Contractor shall indicate at the preconstruction conference the type of post the Contractor elects to use and that type shall be used throughout the Project. Post dimensions and details shall conform to the requirements shown on the Plans. Guardrail posts shall be placed as shown on the Plans. Posts shall be set plumb in holes dug by hand or mechanically. When posts are driven, the manner of driving shall be such as to avoid battering or distorting of posts. Post holes shall be backfilled with acceptance material placed in maximum six inch (150 mm) loose layers and thoroughly compacted. All posts damaged during erection or driving shall be removed and replaced without additional cost. Any damage to post galvanizing shall be repaired by a material meeting the requirements of 711.21. Painting, when called for, shall not be done in damp or freezing weather and shall only be done when the posts are thoroughly dry.

607.3.2-Steel Posts: Galvanized steel posts shall not be painted except for touch up painting with zinc primer as specified.
607.3.3-Pressure Treated Wood Posts: All wood posts shall meet the requirements of Section 710.

607.3.4-BLANK

607.3.5-Offset Blocks: Offset blocks shall be used when called for by the Plans.

607.3.6-Footers for Breakaway Cable Terminal and Special Trailing End Terminal: Footers for breakaway cable terminal and special trailing end terminal shall be constructed of cast-in-place concrete meeting the requirements of 715.12. Concrete shall be placed promptly and without segregation after mixing.

Concrete footers shall be carried down to at least the depth, and shall be not less than the dimensions shown on the Plans. The top of all footers shall be not less than the dimensions shown on the Plans. The top of all footers shall be flush with the ground line and shall be troweled to a smooth finish with a slope to drain away from the post.

After excavating for the footer, the earth coming in contact with the concrete must be moistened to a depth of at least 2 inches (50 mm) just prior to placing the concrete in the hole. No curing will be required other than the placing of not less than 4 inches (100 mm) of loose moistened earth, free from clods or gravel, over the top of the footer immediately after placing the concrete. All excess excavation from footers and loose material used for curing shall be disposed of in a manner satisfactory to the Engineer.

607.4-ERECTING RAIL ELEMENTS:

607.4.1-General: Rail elements shall be erected in a manner resulting in a smooth, continuous installation.

All bolts, except where otherwise required, such as expansion joint bolts and adjustment bolts, shall be drawn tight. Bolts through expansion joints shall be drawn up as tight as possible without being tight enough to prevent the rail elements from slipping past one another longitudinally. Bolts shall be sufficiently long to extend at least 1/4 inch (6 mm) beyond the nuts. Except where required for adjustment, bolts shall not extend more than 1/2 inch (13 mm) beyond the nuts. Bolts through variable thickness posts shall be cut off a maximum of 1/2 inch (13 mm) beyond the nuts.

All metal guardrail elements shall be fabricated in the shop. Field punching, cutting, and drilling of all guardrail elements other than rail may be permitted after it has been demonstrated that it will not result in damage to the surrounding metal and if approved by the Engineer.

When additional slotted holes are required in W-beam to secure rail to post, slotted hole shall be per Standard Details Volume I. Slotted hole shall be field punched or shop fabricated so that they are free from tears, jagged edges and damage to the surrounding metal. Drilling to create slotted holes is prohibited.

It shall be permissible to join Galvanized and Zinc-Aluminum-Magnesium Alloy-Coated Guard Rail together. Additionally it shall be permissible to use galvanized fasteners and end terminals with Zinc-Aluminum-Magnesium Alloy-Coated Guard Rail beams.

Galvanized or zinc-aluminum-magnesium alloy-coated surfaces which have been abraded so that the base metal is exposed, any field welded surfaces, threaded portions of all fittings and fasteners, and cut ends of bolts shall be protected with zinc rich primer or by field galvanizing, when approved by the Engineer.
607.4.2-Type 1 Guardrail (Galvanized Steel Deep Beam / Zinc-Aluminum-Magnesium Alloy-Coated Steel Deep Beam): The rail shall be erected so that the bolts at expansion joints will be located near the centers of the slotted holes. The rail elements shall be spliced by lapping in the direction of traffic. The rail elements at each splice shall make contact throughout the area of the splice. Shop-curved rail shall be used on curves with radii less than 150 feet (45 m).

Any surface damage to galvanized beams or zinc-aluminum-magnesium alloy-coated beams shall be repaired with a material meeting the requirements of 711.21.

When called for, guardrail end terminals conforming to the details shown on the Plans shall be constructed.

607.4.3 through 607.4.4-BLANK

607.4.5-Type 5 Guardrail (Galvanized Steel, Double-Faced / Zinc-Aluminum-Magnesium Alloy-Coated Steel, Double-Faced): This rail shall be erected in accordance with the requirements of 607.4.2 and as shown on the Plans.

607.5-GUARDRAIL REMOVED AND REBUILT OR STORED:

This item shall consist of carefully dismantling, removing, and reerecting or storing, at the location specified on the Plans, of existing guardrail. Rebuilt units shall be of the same type, spacing of members, etc., as original guardrail.

New material specified on the Plans shall conform to the requirements for the construction of new guardrail of the type being reset. It shall be permissible to join Galvanized and Zinc-Aluminum-Magnesium Alloy-Coated Guard Rail beams.

All salvageable materials shall be removed and re-erected (or stored if so specified) with reasonable care. Posts, rails, fabric, and cables for reerecated rails shall be obtained from salvage sources, but the Contractor shall furnish whatever additional bolts, clips, or incidental hardware as may be necessary to complete the guardrail.

Methods of re-erection shall conform to the requirements for the construction of new guardrail of the type being reset, except as modified on the Plans.

Where removal and storage is specified, the bolts, cables, and other hardware shall be carefully removed from all rails, posts, and other members, and all parts shall be sorted and stored at the locations specified. Rails shall be properly stacked, cable shall be free from kinks and rewound on the cable spools, and all such reasonable care shall be exercised in the handling, storing, and preserving of materials as will insure the maximum salvage value for the entire operation.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 712
GUARDRAIL AND FENCE

712.1 through 712.3-BLANK

712.4-GALVANIZED STEEL DEEP BEAM GUARDRAIL, FASTENERS AND ANCHOR BOLTS:
   Galvanized steel deep beam guardrail, fasteners and anchor bolts shall conform to AASHTO M180, Type II, Class A.

712.5 through 712.7-BLANK

712.5-ZINC-ALUMINUM-MAGNESIUM ALLOY COATING GUARDRAIL, FASTENERS AND ANCHOR BOLTS:
   Zinc-aluminum-magnesium alloy-coating deep beam guardrail shall conform to AASHTO M180, Type V or VI, Class A.

712.6 through 712.7 - Blank

712.8-CHAIN-LINK FENCE:
   Chain-link fence shall conform to the requirements of AASHTO M 181. Fence height, gage and details shall be as specified on the Plans.

712.9-ZINC-COATED (GALVANIZED) IRON OR STEEL FARM-FIELD AND RAILROAD RIGHT-OF-WAY WIRE FENCING:
   This fencing shall meet the requirements of AASHTO M 279 and details shown on the Plans. Either of the following styles and coating classes may be used.
   1. Style 1047-6-9 with Class 1 coating
   2. Style 1047-6-11 with Class 3 coating

   Zinc coating for miscellaneous steel fittings and hardware shall conform to the requirements of AASHTO M 232. Zinc coating for clips used for securing fence or wire shall conform to AASHTO M 279, Class 1 coating.

712.10-COATED STEEL BARBED WIRE:
Barbed wire shall meet the requirements of AASHTO M 280, Class 1 or AASHTO M 305, Type I.

712.11-SAFTETY FENCE:
Safety Fence shall be orange in color, commercially manufactured from UV stabilized high-density polyethylene or a suitable substitute approved by the Engineer.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: __________________________
FEDERAL PROJECT NUMBER: __________________________

SECTION 688
FIELD PAINTING OF METAL STRUCTURES

688.2-GENERAL:

688.2.2-Surface Preparation:

DELETE THE CONTENTS OF THE SECTION AND REPLACE WITH THE FOLLOWING:

688.2.2.3-Water Jetting: Shall meet the requirements of SSPC-SP-12, section 2.1.6 SP WJ-1 / NACE WJ-1 “Ultrahigh-Pressure Water Jetting” (UHP WJ), visual standard condition WJ-1, prior to painting.
105.6 – COOPERATION WITH UTILITIES:

ADD THE FOLLOWING:

105.6.1–Division Owned Utilities: It will be the Contractor’s responsibility to locate WVDOH owned utilities (electrical service lines, conduit, signal, etc.) within the project limits. This work shall be incidental to the project.

Department owned utilities or components that are cut, damaged, or destroyed by any work performed as part of the project shall be replaced by the Contractor at no additional cost to the Department.

Lighting, traffic signal, overhead sign plans, etc. if available, may be obtained by contacting Traffic Engineering Division at 304-558-3063.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 601
STRUCTURAL CONCRETE

601.13-PROTECTIVE SURFACE TREATMENT:
   601.13.3-Concrete Protective Coating:

DELETE ENTIRE SUBSECTION 601.13.3 AND REPLACE WITH THE FOLLOWING:

   601.13.3-Concrete Protective Coating: This section covers requirements for materials to be used as surface finishes for designated surfaces of concrete structures. The masonry coatings must hide form marks, patches, and other minor irregularities and prevent deterioration, spalling, and other damage to the concrete due to the action of the weather and deicing chemicals. The Engineer will inspect all concrete surfaces to be coated as stated in the plans and/or contract documents. The field painting (coating) of concrete structures shall follow the provided requirements set forth in this specification unless otherwise noted in the Contract. This specification shall apply to surface preparation, coating application, contractor responsibilities, environmental and worker protection, and waste handling/disposal. All structures shall be pre-cleaned and washed in accordance with Section 685 of the Standard Specifications. The Engineer will ensure a satisfactory ordinary surface finish prior to coating operations. This section shall apply only when the pay item for concrete protective coating is included in the plans.

   601.13.3.1-Physical Requirements of Coating: Physical requirements shall conform to Section 711.5.2.

   601.13.3.2-Concrete Surface Preparation: All concrete surfaces to receive a protective coating shall be prepared in accordance with SSPC-SP 13, Surface Preparation of Concrete, SSPC-The Fundamentals of Cleaning and Coating Concrete, ASTM D4258-Standard Practice for Surface Cleaning Concrete for Coating. All surfaces to receive a protective coating shall be thoroughly cleaned and kept free of oil, form oil, grease, dust, dirt, mud, curing compound, release agents, loose patching mortar, or any other substances that may prevent bonding.
601.13.3.3-Paint Application Requirements: The following surfaces shall be coated, including all beveled edges.

1) Bridge Abutments and Wingwalls – Every exposed surface above a point six inches below ground or fill line. Exclude where epoxy coating is applied.

2) Bridge Pier Caps – The tops (including exposed surfaces of pads, pedestals, and keys), sides and ends. Do not apply the coating to bearing areas. Exclude where epoxy coating is applied.

3) Bridge Superstructure – The tops, inside and outside faces, and ends of all barrier walls, parapets, curbs, and points that will be exposed. Do not apply the coating to the riding surface of the bridge deck.

4) Exposed Surfaces of Substructure and the Superstructure – all surfaces identified in 1), 2), and 3) above and the underneath surfaces of slab overhangs that are outside of exterior girders and the exterior side and bottom of exterior beams or girders, the interior windows of barriers, and all exposed surfaces of piers and abutments. Extend the masonry coating from a point six inches below ground line to the top of the exposed surface.

5) Any other area as designated within the contract plans not mentioned above.

601.13.3.3.1-Weather Conditions: Painting shall not be done when the ambient temperature is below 40° F (5° C) or above 100° F (38° C), or the relative humidity above 90 percent. Painting will only be permitted between the dates of April 15th through October 15th. There will be no painting permitted to occur in a heated containment.

601.13.3.3.2-Paint Storage: Paint and thinners shall be stored in a temperature-controlled environment between 40° F (5° C) and 100° F (38° C). At no time will paint be used beyond the manufacturer’s shelf life.

601.13.3.3.3-Paint Application: The paint shall be applied by spray, brush or roller methods. Brushes or rollers, when used, shall have sufficient body and length of bristle or roller nap to spread a uniform coat. Small touch-up areas may be brushed or rolled, if approved by the Engineer.

Use of an agitated pot shall be mandatory in spray application. The agitator or stirring rod shall reach within 1 inch (25 mm), of the bottom of the pot and shall be in motion at all times during paint application. Coatings shall be mixed in strict accordance with the coating manufacturer’s written instructions. Under certain conditions, it may be necessary to thin or adjust the solvent balance of the paint. The type and amount of solvent to be used shall be that listed on the coating manufacturer’s product data sheet for that material. Upon thinning, the dry film thickness requirement shall still be met by appropriately increasing the wet film thickness.

Application requirements and drying times between coats shall be in accordance with the manufacturer’s recommendations.

Spray guns must be equipped with the recommended size tip for the paint product being applied and shall be held perpendicular (90 degrees) to, and at, the proper distance from the receiving surface. Complete protection shall be provided by the contractor against paint spatter, spillage, overspray, wind-blown paint, or similar releases.
Appropriate containment shall be placed around the work area to protect public and private property. Staging must be adequate to provide access to all areas being painted. Violation of these requirements causing excessive paint waste will be justification for the WVDOD Engineer to order the Contractor to cease all work on the project until corrective action has been taken. The method of cleaning and/or replacement shall be submitted to the Engineer in advance for approval.

Coating application shall be suspended any time the ambient temperature or the temperature of the concrete does not comply with the coating manufacturer’s recommendations.

Prior to application of the materials, furnish the Engineer with copies of the coating material manufacturer’s brochures or booklets. Apply protective coating materials in strict conformity with the manufacturer’s written instructions and apply the material at a uniform rate of at least 50± 10 ft2/gal (1.75± 0.35 m2/L).

Satisfactorily repair or remove any portions of the coating that are not clean, uniform in color, texture, thickness, tightly bonded, or that are damaged before final acceptance of the project and replace them with an acceptable finish and coating.

Provide a neat uniform appearance, and prevent the coating from being dripped, sprayed, or otherwise deposited upon concrete and surfaces not designated to receive the coating. Remove any objectionable deposits or material and repair the surfaces to the Engineer’s satisfaction.

601.13.3.4-Environmental, Worker Protection, And Waste Handling:

601.13.3.4.1-General: Environmental protection shall be used when cleaning, painting, welding or cutting an existing bridge. The containment class, emission assessment methods and levels as defined by the current revision of SSPC Guide 6 shall be as stated in the contract documents. The specific pollution control system which is proposed for the complete capture, containment, collection, and disposal of the “spent material” generated by the work shall be included in the plan.

601.13.3.4.2-“Spent Material”: This shall include material generated by surface preparation operations, and shall be disposed of in accordance with Section 7 of SSPC SP-13. The Contractor shall, at the Contractor’s expense, select a laboratory that will sample and analyze the “spent materials”. The laboratory must be certified by the WVDEP, EPA or by another state’s DEP-equivalent. Certification will be provided to the Engineer prior to the beginning of work. The waste transporter for both hazardous and non-hazardous waste will be listed on the Contractor’s Containment/Disposal Control Plan.

601.13.3.4.3-Permits for Disposal of “Spent Material”: Shall be in accordance with Section 107.2, Permits, Licenses, and Taxes or any other applicable sections of Section 107. The “spent material” shall not be disposed of until authorized by the Engineer and in no case shall “spent material” be allowed to accumulate longer than 90 days prior to transport.

601.13.3.4.4-Additional requirements for all classes of containment: Contractor will provide ground covers beneath the containment area and all equipment where spills are possible to capture inadvertent spills or leaks of debris. Extend the covers a minimum
of 5 feet beyond the area to be covered. Debris shall be removed from the covers at least once per shift, or as directed by the Engineer. If the ground beneath the structure serves as the base of the containment, install and maintain air and dust impenetrable materials such as solid plywood panels or flexible materials such as tarpaulins. Provide explosion-proof lighting inside containment for all paint application. Maintain a minimum of 10 foot-candles for surface.

601.13.3.5-Contractor Responsibilities:

601.13.3.5.1-Concrete Protective Coating Materials: Select masonry coatings from the Department’s List of Approved Materials. Use a material that is readily recognizable by its name, trademark, container, or other feature. All materials shall conform to 711.5.3.

601.13.3.6-Inspection Requirements:

601.13.3.6.1-Inspection of Applied Paint: In the opinion of the Engineer the coating has flaws other than deficiencies in the prescribed dry film thickness, the material shall be repaired or shall be removed and replaced. Defects in the film, including but not limited to runs, sags, mud-cracking, lifting, overspray, and dry spray, shall be corrected until a continuous uniform film has been applied.

Excessive film thickness shall be reduced and insufficient film thickness shall be increased. If the thickness of the finish coat is reduced, a thin coat of the finish shall be reapplied to seal the surface and to blend the area into the surrounding coating. Depending on the defect, total removal and replacement of the affected coating may be required. No unsightly runs or sags shall be visible. All "mud-cracking" and/or "dry overspray" in the paint film shall be removed. Calibration of the thickness gage and dry film thickness measurements shall be in accordance with MP 708.40.00.

601.13.3.6.2-Access for Inspection: The Contractor shall furnish suitable safe access and shall provide a time mutually agreed to for inspecting the structural concrete prior to and after each coating. The Division’s inspector shall approve all repairs. When providing suitable safe access, rubber rollers or other protective devices shall be used. Metal rollers or clamps and other types of fastenings that will mar or damage freshly coated surfaces shall not be used. No temporary attachments, supports for access, or forms, shall damage the coating system. Any damage that occurs from such devices shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

601.13.3.6.3-Repair Procedures for Field Paint Deficiencies: All field repairs to the coating shall be made in strict accordance with the coating manufacturer's recommendations, except where the requirements listed in this specification are more stringent. Any products used during repairs to the coating deficiencies shall be from the same manufacturer as the coating being repaired. Surfaces that will be inaccessible for coating after erection shall be repaired and/or recoated prior to erection. The Engineer is to review and accept a repair plan before deficient areas are repaired. The requirements specified herein for provisions for inspection, mixing, thinning, temperature and humidity, and application shall govern the coating of the repaired areas. In order to avoid abrupt changes in paint thickness, the area adjacent to repair areas shall transition from zero paint thickness to full system thickness within not less than 3 inches (75 mm) of the repair area.
by means of sanding the transition area. The requirements for the dry film thickness of the repair coats are the same as those specified for the paint system.

601.13.3.7 - Submittals: Submittals shall be forwarded through the Prime Contractor and be accepted by the Engineer prior to commencement of the subject work. This is the responsibility of both the Fabricator and the Field Contractor. Electronic submittals will be accepted.

601.13.3.7.1 - Quality Control Plan for Painting: Minimum requirements and document form are set forth in MP 688.02.20.

601.13.37.2 - Containment/Disposal Environmental Control Plan for Existing Concrete Structures: Minimum requirements and document form are set forth in MP 688.03.20.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 711
PAINTS, COATING, OILS, AND INKS

DELETE THE INTRODUCTION AND SUBSECTIONS 711.1 THROUGH 711.22
AND REPLACE WITH THE FOLLOWING:

All shall consist of pigments and vehicles conforming to the general requirements of these
specifications, proportioned and treated to produce materials possessing the detailed composition
and physical properties.

711.1-711.4: BLANK

711.5-CONCRETE PROTECTIVE COATINGS AND STAIN:

711.5.1-General: This specification provides the requirements for concrete protective
coatings and stains. Concrete coatings and stain may be used as surface finishes for designated
surfaces of cement concrete structures. The protective coatings and stains must hide form
marks, patches, and other minor irregularities and prevent deterioration, spalling, and other
damage to the concrete due to the action of the weather and deicing chemicals. These materials
must have protective and corrosion resistance properties. The storage life will be based on
manufacturer recommendations.

711.5.2-Physical Requirements: An independent testing laboratory acceptable to the
Department shall perform the tests described herein on representative samples of the material.
Tests listed herein are the minimum testing requirements to be met. When requested in writing,
the Engineer may accept materials based on conformance to the same type of test but differing
on minor procedural points. Attach copies of test procedures which differ from those stated
herein.

i. Freeze-Thaw Test: Cast and cure 3 concrete specimens no less than 4 by 6 by 6 inches
(100 by 150 by 150 mm). Moist cure specimens for 14 days and then dry in room air
at 60° to 80° F (15° to 27° C) for 24 hours before applying protective coating. Ensure
that there is no excessive oil on specimen forms. Coat sides of specimens (brush
permitted) according to the manufacturer’s directions at a rate of 50± 10ft2/gal (1.75±
0.35 m2/L) and cure at room temperature for 48 hours, after which:

1. Immerse in water at room temperature 60° to 80° F (15° to 27° C) for 3 hours
and remove.
2. Place in cold storage at 5° F (-15° C) for one hour and remove.
3. Thaw at room temperature, 60° to 80° F (15° to 27° C) for one hour.
4. Repeat steps 1), 2) and 3) to complete a total of 50 cycles. At the end of 50 cycles of the Freeze/Thaw Test, ensure that the coated specimens show no visible defects.

ii. **Salt Fog:** Apply the masonry coating to concrete at a rate of 50± 10ft2/gal (1.75± 0.35 m2/L), and test the coating according to ASTM B 117. Expose the coating to a 5 percent sodium (salt) solution for 300 hours, and maintain it at 194° ± 4° F (90± 2° C) during the period of exposure. Ensure that it shows no loss of adhesion or deterioration at the end of the 300 hours.

iii. **Fungus Growth:** Ensure that like protective coatings passes a fungus resistance test as described by federal specifications TT-P-29. After a minimum incubation period of 21 days, ensure that no growth is exhibited on the coatings.

iv. **Color**–The color choices permissible shall conform to SAE International AMS-STD-595 A. The color difference, ΔE, of the acceptance samples shall not be more than five units from the Standard Numbers- 37925, 36650, 37925, 36622

711.5.3-Approval: For approval, the manufacturer shall submit copies of certified test reports to Materials Control, Soils and Testing (MCS&T) Division for review and approval. An independent testing laboratory acceptable to the Division shall perform the tests described herein on representative samples of the material. Tests listed herein are the minimum testing requirements to be met. Attach copies of test procedures which differ from those stated herein. In addition, provide brochures or booklets containing detailed instructions and explanatory remarks about surface preparation, application procedures, and other pertinent operations.

711.6-ZINC PRIMERS:
711.6.1-ORGANIC ZINC PRIMER:

711.6.1.1-**General:** This specification provides the requirements for an organic zinc rich primer. The Organic Zinc Primer may be used in the shop on new steel or in the field on existing steel. The steel shall be capable of being blast cleaned to a near-white finish, meeting SSPC-SP-10 requirements for new steel, and SSPC-SP-6, for existing steel. When used as a shop primer, the material shall have a minimum slip coefficient of 0.50 (Class B) when tested in accordance with “Test Method to Determine the Slip Coefficient for Coatings used in Bolted Joints” as adapted by the Research Council on Structural Connections. Acceptance for field painting will be based on batch testing of materials that do not meet the minimum of 0.50 (Class B) slip coefficient. Initial approval of all material will be based on complete Division testing to assure specification compliance. The primer may be top coated with materials meeting the requirements of Subsections 711.22.3 and 711.22.4. The dry film thickness requirement will be based on manufacturer recommendations. The paint storage life will be based on manufacturer recommendations.

711.6.1.2-**Physical Requirements:** Shall be as per SSPC Paint 20, Type II with the following exceptions:

i. The VOC shall not exceed 3.5 lbs /gal (420 g /l).
ii. Viscosity of the mixed paint shall be in accordance with ASTM D 562.
Variance shall be within ±10 Krebs Units of the viscosity of the previously qualified paint.

iii. Weight per gallon of the mixed paint shall be in accordance with ASTM D 1475. Variance shall be within ±0.5 pounds (225 g) of the weight per gallon of the previously qualified paint.

711.6.2-Inorganic Zinc Primer:

711.6.2.1-General: This specification provides the requirements for an inorganic zinc rich primer. The Inorganic Zinc Primer shall be shop applied only, over a near white blasted surface, meeting SSPC – SP-10 requirements. The primer shall have a minimum slip coefficient of 0.50 (Class B) when tested in accordance with "Test Method to Determine the Slip Coefficient for Coatings used in Bolted Joints" as adapted by the Research Council on Structural Connections. The paint storage life will be based on manufacturer recommendations.

711.6.2.2-Physical Requirements: This primer shall meet the requirements set forth in AASHTO M 300 with the following exceptions:

i. The VOC shall not exceed 3.5 lbs/gal (420 g/l).

ii. The adhesion shall be a minimum of 4B when tested in accordance with ASTM D3359, Method B.

iii. Viscosity of the mixed paint shall be in accordance with ASTM D 562. Variance shall be within ±10 Krebs Units of the viscosity of the previously qualified paint.

iv. Weight per gallon of the mixed paint shall be in accordance with ASTM D1475. Variance shall be within ±0.5 pounds (225 g) of the weight per gallon of the previously qualified paint.

711.7-711.11: BLANK

711.12-EPOXY COATINGS:

711.12.1-General: This specification provides the requirements for a two component, modified epoxy coating for use as a spot primer or a one coat system for use on poorly prepared surfaces on most existing structures. The coating may be used as a primer over steel that has been cleaned to a minimum of SSPC-SP-2. If it is used as a primer, it may then be coated with the manufacturer’s recommended intermediate and/or top coat from the Division’s approved list of Zinc Rich Low VOC Systems (711.22). This coating shall also be suitable for use over zinc rich primers. All ingredients are not specified; however, the finished product shall comply with the requirements prescribed. The paint storage life will be based on manufacturer recommendations.

711.12.2-Composition: The pigment shall not react with the vehicle or interfere with the cure. The pigment may be aluminum flake powder or paste. The metallic aluminum pigment may be replaced by other pigments and coloring agents necessary to provide the specified color. The vehicle shall be modified epoxy resin and curing agent. The vehicle shall be formulated to permit trouble free application during normal humidity conditions.

i. Color – The color choices permissible shall conform to SAE International
AMS-STD-595 A. The color difference, ΔE, of the acceptance samples shall not be more than five units from the Standard Numbers- 20062, 26373

ii. Gloss @ 60° shall be 30-50 for semi-gloss and 51 or greater for gloss finishes.

iii. Flat finishes shall have a gloss of 29 or less.

### 711.12.3-Physical Requirements:
Steel panels shall meet the requirements of ASTM D609, Type III. Steel panels shall be sandblasted to a white metal blast finish in accordance with SSPC-SP-5, exposed to the atmosphere for 30 days so uniform rusting occurs, and then hand cleaned with a wire brush in accordance with SSPC-SP-2. The panel shall then be spray applied with epoxy maintenance coating according to manufacturers' recommendations.

    i. Dry to touch @ 5 mils, (125 μm) dry, 24 Hours Maximum
    ii. Dry hard @ 5 mils, (125 μm) dry, 72 Hours Maximum
    iii. Weight per gallon, 10.5 Lbs. Minimum
    iv. Accelerated Weathering: Panels shall be tested in accordance with ASTM G 154. After 1,000 hours exposure, the coating shall show no rusting, blistering, or loss of adhesion to the test panel.
    v. Salt Fog: Panels shall be scribed to the base metal with an X of at least two inch (50 mm) legs. The test panels shall then be tested in accordance with ASTM B 117. After 1,000 hours of continuous exposure, the coating shall show no loss of bond, nor shall it show rusting or blistering beyond 1/16 inch (2 mm) from the center of the scribe mark.

### 711.12.4-Application Properties:
The mixed paint, when thinned in accordance with manufacturer's recommendations, shall be capable of being sprayed in one coat at a wet film thickness of 10 mils (250 μm) without runs or sags. The properly thinned paint shall be capable of brush and roller application. The manufacturer's current printed instructions for application of the epoxy maintenance coating shall be submitted to the Division for review and approval prior to application. The paint storage life will be based on manufacturer recommendations.

### 714.13 through 711.20: BLANK

### 711.21-REPAIR OF DAMAGED GALVANIZED SURFACES:
Repair of damaged galvanized surfaces will be done using a primer meeting the requirements Section 711.6.

### 711.22-ZINC RICH LOW VOC SYSTEM:

#### 711.22.1-General:
Initial approval of the system will be based on testing of the complete system for specification compliance. Each product in the system shall be from the same paint manufacturer. Each coat shall be a contrasting color to the one previously applied. The use of the intermediate coat meeting 711.22.3, shall be at the option of the paint manufacturer. In either case, the adhesion of the system shall be a minimum of 4A when tested in accordance with ASTM D3359, Method A. The adhesion test shall be conducted approximately 14 days after application of the top coat. All products shall have a maximum VOC of 2.8 lbs / gallon (336 g/l) with exception of the primer, which shall have a maximum VOC of 3.5 lbs / gallon
(420 g/l). The paint storage life will be based on manufacturer recommendations. The prime fabricator is responsible for choosing the paint system when shop applied.

**711.22.2-Primer:** The primer shall meet the requirements of 711.6.

**711.22.3-Intermediate Coat:** This material shall meet the manufacturer's specification and shall be compatible with a primer (711.6) and the top coat (711.22.4).

**711.22.4-Top Coat:** This material shall meet the manufacturer’s specification and shall meet the requirements of 711.22.4.1. After system approval, all topcoat material shall be batch tested for color and dry time.

**711.22.4.1-Physical Requirements:**
1. **Dry Hard**-24 Hours Maximum
2. **Color**—The color choices permissible shall conform to SAE International AMS-STD-595 A. The color difference, ΔE, of the acceptance samples shall not be more than five units from the Standards Numbers- 20062, 26373
3. **Gloss @ 60°** shall be 30-50 for semi-gloss and 51 or greater for gloss finishes. Flat finishes shall have a gloss of 29 or less.

**711.22.5-System:** The system shall be composed of a primer and topcoat. Application and dry film thickness shall be based on the manufacturer recommendations. The use of the intermediate coat shall be at the option of the paint manufacturer.

**711.22.5.1-System Requirements:**
1. **Intercoat Adhesion**—The adhesion of the system shall be a minimum of 4B when tested in accordance with ASTM D3359, Method B.
2. **Accelerated Weathering**—After cycling 1000 hours there shall be no evidence of checking, cracking, rusting, or blistering. The degree of chalking shall not be less than No. 6 when tested according to ASTM G 154. The color difference after 1000 hours shall be no more than five ΔE units.
3. **Salt Fog**—Testing shall be in accordance with ASTM B117. After 1000 hours of continuous exposure, there shall be no evidence of checking, cracking, rusting, or blistering.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 640
FIELD OFFICE AND STORAGE BUILDING

640.4-FIELD OFFICE:

640.4.5-Minimal Field Office: The field office shall have a minimum floor space of 100 square feet (9.3 square meters) with a minimum plan dimension in one direction of 6 ft. (1.8 m). When a sanitary enclosed toilet is not provided, a chemically treated portable toilet shall be provided. The office shall be furnished with a desk, chair, one fireproof filing cabinet equipped with locks, one desk top copier capable of producing 8½ x 11 and 8½ by 14 copies and a phone, fax and answering (message) machine that utilizes the same phone line. The door for the field office shall be provided with a suitable lock. A sanitary water cooler using bottled water or approved equal shall be provided. The requirements of sections 640.10 shall not apply.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
SUPPLEMENTAL SPECIFICATION  
FOR  
SECTION 657  
ROADWAY SIGN SUPPORTS  

DELETE THE ENTIRE CONTENTS AND REPLACE WITH THE FOLLOWING:

657.1-DESCRIPTION:  
This work shall consist of the fabrication and erection of all supports for roadside mounted signs in accordance with the requirements of the Plans and of these Specifications. This shall include the supports for all signs which are located outside of the shoulder and do not extend over the shoulder. 

All details not specified or not shown on the Plans shall conform to the details and requirements set forth in the following specifications and publications:

i. West Virginia Department of Transportation, Division of Highways, Standard Details Book Vol. II, Signing, Signals, Lighting, Markings, and ITS, latest issue, including revisions (further referenced to herein as the Standard Details).

ii. The Manual on Uniform Traffic Control Devices for Streets and Highways, latest issue, as printed by the Federal Highway Administration, U.S. Department of Transportation. (Referred to as the MUTCD).


657.2-MATERIALS:  
Materials furnished shall be of new stock, shall be the product of reputable manufacturers of signing supports and accessories, shall conform to the Specifications, and shall meet the approval of the Engineer.

657.2.1-Beams: Steel Beams such as shown on Standard Detail sheets TE1-3A through TE1-3C shall be standard wide flange shapes fabricated from steel conforming to ASTM A36 or ASTM A572 Grade 50. Steel conforming to ASTM A992 and dual certified to ASTM A572 Grade 50 may also be used. The beams shall be galvanized in accordance with ASTM A123.
657.2.2-Plates: Flat steel plates such as stiffener plates, base plates, hinge plates, arm plates, and gusset plates shown on various Standard Detail sheets shall conform to ASTM A36 and shall be galvanized in accordance to ASTM A123.

657.2.3-Structural Connection Bolts: Steel structural connection bolts and associated hardware shown on various Standard Detail sheets shall conform to the following requirements. Bolts: ASTM F3125 Grade A325, Type I. Nuts: ASTM A563, Grade DH with lubricant contrasting with the color of the galvanizing. Washers: ASTM F436, Type I. All galvanized in accordance to ASTM F 2329.

657.2.4-Keeper Plates: Steel keeper plates such as shown on Standard Detail sheets TE1-3A through TE1-3C and TE1-5A through TE1-5C shall conform to ASTM A653, designation CS, and shall be galvanized. Thickness for use with Steel Beam supports shall be 20 gauge. Thickness for use with Pipe Post supports shall be 28 gauge.

657.2.5-Brass Shims: Brass shims such as shown on Standard Detail sheets TE1-3A through TE1-3C and TE1-5A through TE1-5C shall be fabricated from brass shim stock or strip meeting ASTM B36.

657.2.6-Pipe: Steel pipe such as shown on Standard Detail sheets TE1-5A through TE1-5C shall conform to the requirements of ASTM A53, TYPE E or S, Grade B.

657.2.7-Friction Caps: Steel friction caps such as shown on Standard Detail sheets TE1-5A through TE1-5C shall conform to ASTM A653, designation CS, and shall be zinc electrodeposited coated in accordance with ASTM B633, Class 12.

657.2.8-Anchor Bolts: Anchor bolts for cast-in-place applications such as shown on Standard Detail sheets TE1-5A through TE1-5C and TE2-2 shall conform to the following requirements. Bolts: ASTM F1554 Grade 55. Nuts: ASTM F563 Grade A. Washers: ASTM F436. All galvanized in accordance with ASTM B695.


657.2.10-Tubular Steel: Tubular steel such as shown on Standard Detail sheets TE2-1A through TE2-1B and TE2-3 shall conform to ASTM A500, Grade B, seamless or welded. Galvanized in accordance to ASTM A123.

657.2.11-U-Channel Supports and Breakaway Splice Devices: U-channel supports utilized shall be listed on the Division Approved Products List (APL) for U-Channel Posts. MP 707.02.13 shall be followed.

When required, Breakaway Splice Devices shall be supplied with the u-channel supports; such as shown on Standard Detail TE1-7B.
657.2.12-Square Tube Supports: Square tube supports shall conform to the requirements of 709.53.

657.2.13- Omni-Directional Breakaway Devices: Omni-Directional Breakaway Devices shall be designed for use with Steel Beam supports shown on Standard Detail sheets TE1-3A, TE1-3B, and TE1-3C. When required in the project plans, Omni-Directional Breakaway Devices shall be utilized with specified Steel Beam type support assemblies in order to convert the breakaway connection from bi-directional to omni-directional.

The device used shall be listed on the WVDOH Approved Products Listing (APL) for Roadside Sign Support Accessories. Omni-Directional Breakaway Devices shall conform to requirements of 709.52.

657.2.14- Back to Back U-Channel Breakaway Devices: Back to Back U-Channel Breakaway Devices shall be designed for use with 4-lb/ft and/or 6-lb/ft back to back supports shown on Standard Details sheets TE1-7A and TE1-7B. When required in the project plans, Back to Back U-Channel Breakaway Devices shall be utilized with specified back to back support assemblies in order to create a breakaway base connection.

The device used shall be listed on the WVDOH Approved Products Listing (APL) for Roadside Sign Support Accessories. Back to Back U-Channel Breakaway Devices shall conform to 709.54.

657.2.15- Surface Mount Breakaway Devices: Surface Mount Breakaway Devices shall be designed for use with 2-lb/ft and/or 3-lb/ft u-channel supports shown on Standard Details sheets TE1-7A and TE1-7B, and/or 1-3/4” x 14-gauge Square Tube Supports. When required in the project plans, Surface Mount Breakaway Devices shall be utilized with specified u-channel support assemblies which are located on asphalt or concrete surfaces.

The Contractor shall select the Surface Mount Breakaway Device to be used following the guidance on Standard Detail TE1-7B.

The device used shall be listed on the WVDOH Approved Products Listing (APL) for Roadside Sign Support Accessories. Surface Mount Breakaway Devices shall conform to 709.51.

A complete anchoring system for securing the device on the asphalt or concrete is also required.

657.2.16-Types A and B Barrier Wall Sign Support Brackets: Types A and B Barrier Wall Sign Support Brackets shall be designed for use with 1-3/4-inch x 14-gauge Square Tube Supports. When required in the project plans, Types A and/or B brackets shall be utilized with specified assemblies to be installed on top of a median barrier wall or parapet. Type A brackets are intended to be specified for use with barriers less than 10-inches in width at the top. Type B brackets are intended to be specified for use with barriers 10-inches or greater in width at the top.

A complete anchoring system for connecting the bracket to the concrete and hardware for connecting the square tube support to the bracket are required.
The bracket used shall be listed on the WVDOH Approved Products Listing (APL) for Roadside Sign Support Accessories. The requirements for Types A and B Barrier Wall Sign Support Brackets are specified in 709.55.

657.2.17- Anchors for Brackets: It shall be the responsibility of the bracket fabricator to select and specify an appropriate anchoring system for retrofit installations of the following sign brackets: Types C and D Barrier Wall Sign Support Brackets as shown on Standard Detail sheets TP3-2 and TE2-3; Types K and L Bridge or Retaining Wall Sign Mounting Brackets.

Mechanical or chemical anchoring systems may be used. The anchors and associated hardware components of the anchoring system shall be galvanized steel. The anchoring system shall be selected based on the design loading information provided on the previously referenced Standard Detail sheets. It shall be the fabricator’s responsibility to verify the dimensions of the barrier, parapet, or retaining wall if necessary in order to select the anchoring system.

All specifications and details related to the anchoring system shall be included as part of the fabricator’s shop drawings. All necessary materials to install the anchoring system shall be provided by the fabricator with the bracket.

657.2.18- Concrete: All concrete shall be Class B in accordance with Section 601.

657.2.19- Reinforcing Steel: All reinforcing steel shall meet the requirements of Section 602.

CONSTRUCTION METHODS

657.3- FABRICATION:

657.3.1- General: Fabrication of all parts of supports shall be in accordance with dimensions shown on the Plans and Standard Drawings. Work shall be done in a uniform workmanlike manner.

657.3.2- Shop Drawings: The Contractor shall submit Shop Drawings showing all dimensions, quantities, and fabrication details for all supports and brackets for the Engineer’s approval. All associated accessories and hardware to be supplied with the supports and brackets shall be included, including details and specifications for retrofit anchors as described in Section 657.2.17. Eight copies of the Shop Drawings shall be submitted. Multiple submissions will be permitted. However, all Shop Drawings for Steel Beam Supports shall be submitted in one submission; all Shop Drawings for Pipe Post Supports shall be submitted in one submission; and all Shop Drawings for Parapet, Retaining Wall, and Barrier Brackets shall be submitted in one submission.

657.3.3- Structural Bolt Tightening: When fully tightening structural connection bolts as part of the shop fabrication process, only un-weathered hardware components in new condition shall be used. All nuts shall be pre-coated with a lubricant as specified herein. After pre-assembly of the connections, the bolts shall be brought to a “snug tight” condition. Prior to snug tightening the nuts, if the threads of the bolts have not been lubricated, were last lubricated more than twenty-four hours prior, or have gotten wet since they were last lubricated, lubricant
shall be applied to the bolt threads. Beeswax or toilet ring wax may be used. The assembler may turn the nuts while holding the heads of the bolts or vice versa. If the heads of the bolts are turned, the assembler shall apply lubricant to the face of the washer that the bottom of the bolt head is to be tightened against.

The bolts shall be snug tightened in a star pattern. “Snug Tight” condition is defined by the Research Council on Structural Connections (RCSC) as “the tightness that is attained with a few impacts of an impact wrench or the full effort of an ironworker using an ordinary spud wrench to bring the plies into firm contact”.

After the snug tightening process, no less than seventy-five percent of the surface areas of the faces being connected should be in visible contact. The assembler shall take care during the snug tightening process to ensure that components being assembled remain properly aligned, loosening the connection and repeating the snug tightening process if necessary.

After the snug tightening process has been completed, each nut or bolt head shall be fully tightened by the turn-of-the-nut method. This shall require further tightening each fastener one-third (1/3) of a turn, which shall be equivalent to two flats of a typical nut or bolt head with five flats. This shall be verifiable by first marking the nut or bolt head on one of the flats and placing a corresponding mark on the component two flats away. The fasteners shall be fully tightened in a star pattern and incrementally by fully tightening each over at least two cycles.

657.3.4-Welding: The welding of steel shall be in accordance with the requirements of American Welding Society Specification D1.1 and shall be done by qualified welders.

657.4-ERECTION:

657.4.1-General: All sign supports shall be installed at the points designated on the Plans or by the Engineer in accordance with these specifications, the Plans, and approved shop drawings and shall be erected in reasonably close conformity to the locations, elevations, and angles shown on the Plans or established by the Engineer.

The Contractor shall take full responsibility for checking all cross sections at approved sign locations to determine final support lengths. Lateral placement of sign assemblies and necessary support lengths shall be determined in accordance with the offset and mounting height requirements shown in the Plans or Standard Details TP3-1A through TP3-1C.

Before proceeding further, the Contractor shall initially establish the location of each sign in accordance with the Plans or as directed by the Engineer and shall mark each site with construction stakes. The Contractor shall furnish stakes, paint, other materials, and labor for performing the locating and staking as described. When the sites have been staked and are ready for inspection, the Contractor shall inform the Engineer, who will check and approve the site or make necessary changes. Centerline station information will be furnished to the Contractor by the Engineer.

All existing or proposed assembly locations are approximate. In cases where an existing assembly, including supports, is to be removed and replaced with a new assembly, the new assembly shall be located as close as possible to the original and within 10-feet unless otherwise approved by the Engineer.

In cases where existing roadside sign supports are to remain in place with new signs to be installed, the Contractor shall plumb the supports as necessary, and shall clear any existing
breakaway connection of any obstructions. Costs associated with this work shall be incidental to the Contract bid items.

The Contractor shall take into consideration the Sign Orientation Requirements shown on Standard Detail TP3-1B when determining the final proposed location for each assembly support. Unique orientation requirements for chevron and R4-7 signs are shown on Standard Details TP3-2 and TE11-3C, respectively.

657.4.2 - Excavation: The Contractor shall perform excavations for each support requiring a concrete foundation to the depths and dimensions shown on the Plans or as directed by the Engineer to obtain a suitable foundation. Excavation may be accomplished manually or by mechanical means. The Contractor is advised that the grading specifications permit the construction of embankment of rock fill to at least 12-inches below the bottom of the subbase.

If solid rock or large boulders are encountered in excavation, it shall be removed, to the satisfaction of the Engineer, to a sufficient depth in order to obtain the stability which would have been obtained had the excavation been made in earth to the depth required by the Plans or Standard Details.

The Contractor shall remove all excavated material from the site that is not needed for backfill or, if permitted by the Engineer, shall spread this material out in the area immediately surrounding the foundation location to the satisfaction of the Engineer. The Contractor shall restore all disturbed areas to within reasonable conformity of their original conditions by grading, seeding, mulching, and/or fertilizing as directed by the Engineer. No separate payment will be made for these operations or required materials.

The Standard Detail drawings are compiled on the basis of average soil conditions. Soil conditions surrounding specific foundations may warrant lesser foundations or may require larger foundations. In these cases, the Contractor may adjust the size of specific foundations with the written approval of the Engineer. The Engineer may direct the Contractor to adjust the foundation dimensions if determined to be necessary. Any work in such cases shall be performed without change in the unit bid price.

If the sides of the excavation are determined by the Engineer to be unstable, forms shall be used to support the sides of the excavation. The forms shall be placed in such a manner as not to disturb the adjacent soil. If the Contractor elects to remove the form, the removal shall be done immediately after the concrete is placed so that the flowing concrete may fill the space occupied by the form. Otherwise, the form shall become a permanent part of the installation. In the latter case all portions of the form above ground level shall be removed after the concrete has cured. The Engineer will make the final determination as to when forms are necessary. This form work shall be performed at the expense of the Contractor and no compensation will be allowed therefor.

If a support foundation is to be installed within the area of an existing concrete or asphalt surface and requires a concrete foundation, the concrete or asphalt shall be carefully opened by drilling, saw cutting, or other suitable methods approved by the Engineer that will not cause unnecessary damage to the surrounding surface. The Contractor shall be responsible for removal and proper disposal of all excavated materials.

The Contractor shall contact WV 811 and shall notify all applicable non-WV 811 participating utilities prior to beginning excavation, support driving, or conduit jacking activities. The Contractor shall hand dig to locate lines or open cut in areas of possible conflict, as determined by the Engineer. The Contractor shall also be responsible for locating and
verifying Division owned underground conduit to avoid conflict or damage. All such work shall be incidental to the Contract bid items. All costs associated with any disruption of services as a result of the Contractor’s activities shall be the Contractor’s sole responsibility.

657.4.3-Foundation Placement: All concrete for each foundation shall be placed in one placement with no cold joints. All concrete footings shall be flush with the uphill side of the ground line, with the edges of the foundation being level. The top of concrete for each foundation shall be finished neatly and smooth, including the outside edges. The edges of foundations placed within areas of existing concrete or asphalt surfaces shall be finished neatly and smoothly to match with the edges of the area of asphalt or concrete surface which was removed. The concrete shall be finished such that it slopes slightly down and away from the stub or the bolt circle of the anchor bolts for drainage purposes. The Contractor shall take care in order to install all anchor bolts and stub supports as level as possible and with the proper embedment. Specific details pertaining to support foundations are contained in the Standard Details or shall be shown in the project Plans.

If the foundation is being placed on a slope that is 4:1 or greater and it is not possible to build up the downhill side of the ground slope as shown in the Standard Details to allow the edges of the top of the foundation to be placed level, the Contractor shall utilize a suitable concrete form which allows the round cross-sectional shape of the foundation to be maintained above ground level. The form shall also allow for the portion of the form above ground level to be removed after the concrete has sufficiently cured. After the concrete has cured, the portions of the form above ground level shall be removed. No additional compensation shall be paid for the use of and removal of a form, if required.

657.4.4-Backfilling: If any backfilling is required, excavations shall be backfilled with random material, approved by the Engineer, in horizontal layers not to exceed 4-inches after compaction. Each lift shall be compacted to the satisfaction of the Engineer. Testing is not required.

All surplus material shall be removed from the right-of-way and the backfill finished flush with surrounding natural ground, including replacement of any damaged facilities or appurtenances. The Contractor shall restore all areas disturbed by this excavation or other operations within reasonable conformity to their original conditions including grading, seeding, mulching and/or fertilizing as directed by the Engineer. The cost of backfilling materials or operations shall be incidental to the Contract bid items.

657.4.5-Support, Breakaway Device, and Bracket Installation: 657.4.5.1-General: All supports requiring concrete foundations shall not be installed until the concrete has cured for a period of seven days unless otherwise approved by the Engineer. All sign posts and their stubs or anchor bolts shall be set plumb so that the sign will be level and shall be set at the proper angle with the roadway as shown in the Standard Details.

Protective coatings for any supports, brackets, or associated components damaged for any reason prior to or during installation shall be repaired. For galvanized surfaces, the repair shall be accomplished by the application of a zinc-rich paint conforming to Military Specification MIL-P 21035, applied as recommended by the manufacturer including surface preparation, or as directed by the Engineer.
Various Standard Details sheets referenced herein require the use of a “click” type torque wrench meeting the specifications herein. The wrench used shall be a “click” type manual torque wrench and shall meet either the requirements of International Organization for Standardization (ISO) Specification 6789 or American Society of Mechanical Engineers (ASME) Specification B107.300. Prior to tightening any fasteners on the project which require the use of a wrench meeting this specification, the Contractor shall provide the Engineer with a copy of a calibration certificate for each wrench to be used on the project. The date of the calibration shall be one (1) year or less prior to the letting date of the Contract. The certificate provided shall be from a calibration lab that is ISO 17025 accredited, with the certificate indicating as such. Both the certificate and wrench shall display matching serial numbers.

657.4.5.2-Soil Anchored U-Channel Supports: When installing soil anchored u-channel supports not requiring a foundation, the supports shall be driven either manually or by mechanical means to the required line and grade and shall be installed as plumb as possible. The Engineer may direct the Contractor to increase the required driving depth if determined to be necessary due to soil conditions. During driving, the support end shall be protected by a special driving cap if driven manually. If driven by a mechanical device, an appropriate driving head shall be used that is designed not to damage the support. Any support bent or otherwise damaged and determined by the Engineer to be unfit for use in the finished work shall be removed from the site and replaced by the Contractor at their expense. Except in cases where a breakaway splice device is required per Standard Detail TE1-7B, soil anchored supports may be directly driven without a stub and splice connection, or the Contractor may use an approved breakaway splice device at their option with no additional compensation.

Soil anchored supports shall be sufficiently plumb after installation. Otherwise, this shall be cause for rejection at the discretion of the Engineer requiring the Contractor to straighten or remove and reinstall the supports at the Contractor’s expense if directed.

657.4.5.3-Back to Back U-Channel Supports: U-channel supports which are to be erected back-to-back shall be stitch bolted together in accordance with Standard Detail TE1-7B. All back to back supports shall require a concrete foundation as shown on Standard Detail TE1-7B.

Assemblies not requiring a breakaway device shall require the concrete to cure with the entire support installed. The Contractor shall be responsible for utilizing a method to hold the supports secure and plumb during the curing process. No additional compensation shall be paid for this.

After installation and curing, the support shall be plumb within ten degrees of vertical in all directions. This shall equate to no more than 3/16-inch horizontally out of level over 1-foot of length. Otherwise, this shall be cause for rejection at the discretion of the Engineer requiring the Contractor to relocate and reinstall the foundation and support if directed. This shall include removing the foundation for the rejected support to a minimum of 6-inches below ground level.

657.4.5.4-Steel Beam and Types 1-5 Pipe Post Supports: Steel Beam and Types 1-5 Pipe Post Supports shall be plumbed in accordance with the Standard Details as needed.
No more than 1/4-inch of shims in total thickness may be used for any one connection bolt of the support. The Contractor shall shim the assembly within the allowances described above to be as plumb as possible.

All base connection bolts shall be tightened to within the torque ranges specified on the Standard Details using a wrench meeting the requirements of Section 657.4.5.1, unless an Omni-Directional Breakaway Device is specified and requires the base connection bolts to be eliminated. The procedure specified in Section 657.3.3 shall be used for field assembly of any hinge plate connections.

Upon final installation, the support shall be plumb within ten degrees of vertical in all directions. This shall equate to no more than 3/16-inch horizontally out of level over 1-foot of length. Otherwise, this shall be cause for rejection at the discretion of the Engineer requiring the Contractor to relocate and reinstall the foundation and support if directed. This shall include removing the foundation for the rejected support to a minimum of six 6-inches below ground level.

In cases where the Contractor is required to replace the portion of a Steel Beam support above the hinge plate with the lower portion to remain in place, the length of the new upper support shall be the height required by the specified sign(s) plus an additional 4-inches. All plates and hardware associated with the hinge plate connection shall be new. The hinge plate connection shall be field tightened as specified herein.

657.4.5.5-Types 6-9 Pipe Post Supports: Leveling of Types 6-9 Pipe Post Supports installed on concrete foundations shall be accomplished using leveling nuts and washers on each anchor bolt. One leveling nut with washer shall be installed on each anchor bolt to its approximate position. After setting the support in place, the support shall be adjusted as closely as possible to a plumb vertical position by adjusting the lower nuts. After leveling, the entire top face of all washers placed under the base plate shall be engaged with the base plate. The top anchor bolt nuts shall then be fully tightened in accordance with the anchor bolt tightening procedures specified in Section 658. After fully tightening, the entire length of all top nuts shall be engaged on the anchor bolts. The procedure specified in Section 657.3.3 shall be used for field assembly of the support arms.

After installation, the vertical portion of the support shall be plumb within ten degrees of vertical in all directions. This shall equate to no more than 3/16-inch horizontally out of level over 1-foot of length. Otherwise, this shall be cause for rejection at the discretion of the Engineer requiring the Contractor to relocate and reinstall the foundation and support if directed. This shall include removing the foundation for the rejected support to a minimum of six 6-inches below ground level.

657.4.5.6-Omni-Directional Breakaway Devices: Omni-Directional Breakaway Devices for use with Steel Beam supports shall be installed in accordance with the manufacturer’s specifications. A copy of the manufacturer’s installation specifications shall be provided to the Engineer prior to proceeding with installation. Any hardware components of the device for which the manufacturer specifies a particular torque requirement shall be tightened using a wrench meeting the requirements of Section 657.4.5.1.
657.4.5.7-Back to Back U-Channel Breakaway Devices: Back to Back U-Channel Breakaway Devices shall be installed in accordance with the manufacturer’s specifications. A copy of the manufacturer’s installation specifications shall be provided to the Engineer prior to proceeding with installation. Any hardware components of the device for which the manufacturer specifies a particular torque requirement shall be tightened using a wrench meeting the requirements of Section 657.4.5.1.

657.4.5.8-Surface Mount Breakaway Devices: Surface Mount Breakaway Devices shall be installed in accordance with the manufacturer’s specifications. A copy of the manufacturer’s installation specifications shall be provided to the Engineer prior to proceeding with installation.

The anchoring system used shall be that which is supplied by the manufacturer. The underside of the base of the device shall be shimmed if necessary in order for the support to be as plumb as possible in all directions after installation. Material used for shimming shall be materials approved by the Engineer such as brass shims or galvanized steel. Any hardware components of the device for which the manufacturer specifies a particular torque requirement shall be tightened using a wrench meeting the requirements of Section 657.4.5.1.

Upon final installation, the support shall be plumb within ten degrees of vertical in all directions. This shall equate to no more than 3/16-inch horizontally out of level over 1-foot of length. Otherwise, this shall be cause for rejection at the discretion of the Engineer requiring the Contractor to add additional shims at the Contractor’s expense if directed.

657.4.5.9-Bridge, Retaining Wall, and Barrier Wall Brackets: This specification shall include Types K and L Bridge or Retaining Wall Sign Mounting Brackets and Types A, B, C, and D Barrier Wall Sign Support Brackets. The anchorage for Type L Bridge or Retaining Wall Sign Mounting Brackets shall be cast-in-place or retrofitted, as specified in the Plans. Details for cast-in-place anchors are shown in the Standard Details. The anchorage for all Barrier Wall Sign Support Brackets specified above and Type K Bridge or Retaining Wall Sign Mounting Brackets shall be retrofitted.

Anchors to be retrofitted into newly placed concrete shall not be installed without approval of the Engineer. The Contractor shall obtain approval from the Engineer before installing brackets on cast-in-place anchors. The Contractor shall insure that anchor chemical adhesive used for retrofit installations has sufficiently cured before placing the brackets.

Mechanical or chemical adhesive type anchors for retrofit applications shall be installed strictly in accordance with the instructions provided by the bracket manufacturer or fabricator. This shall include recommended procedures for cleaning the drilled holes and recommended ambient air and mounting surface conditions in the case of chemical adhesive systems.

Once the bracket is placed into the position on the anchors, the anchors shall be tightened. Cast-in-place anchors for Type L Bridge or Retaining Wall Sign Mounting Brackets shall be tightened in accordance with the anchor bolt tightening procedures specified in Section 658, except the amount of nut tightening rotation shall be one-half the amount specified. Retrofit anchors for all bracket types shall be tightened in accordance with the instructions provided by the manufacturer or fabricator.
After the bracket anchors are tightened, supports to be attached to the brackets may be installed in accordance with the Standard Details and the specifications herein. Note, the bracket to pipe post connection bolts for Type L Bridge or Retaining Wall Sign Mounting Brackets shall be fully tightened in accordance with the procedure specified in Section 657.3.3.

Vertical support installation hardware for Types A and B Barrier Wall Sign Support Brackets shall be that which is supplied by the bracket manufacturer and shall be installed in accordance with the instructions provided by the bracket manufacturer. Any hardware components for which a particular torque requirement is specified shall be tightened using a wrench meeting the requirements of Section 657.4.5.1.

Hardware used to connect the vertical supports of Type C Barrier Wall Sign Support Bracket shall be as specified in Section 657.2.9. The fasteners shall be tightened in accordance with the Standard Detail. Note, it is required to install spacers between the u-channel welded to the bracket base plate and the support. Spacers shall be additional nuts and/or washers. The Contractor shall be responsible for determining the necessary quantity of additional nuts and/or washers such that when the fasteners are tightened, the support nested inside of the welded stub comes into firm contact with the angled web portions of the welded stub but does not cause undue stress on the angled webs. No additional compensation shall be paid to the Contractor for the additional nut and/or washer spacers.

657.4.6-Support or Bracket Removal: Removal of roadside sign supports shall include removing the support and foundation to a minimum of 6-inches below ground level and restoring the ground surface to its original condition. This shall include grading, seeding, mulching, and/or fertilizing as determined to be necessary by the Engineer.

Removal of parapet, retaining wall, and barrier brackets shall include removing the bracket and supports attached to it. Mounting anchors shall be cut off flush with the concrete.

The cost of this item shall also include the removal of attachments to the supports as required by the Plans or otherwise directed by the Engineer. In cases where the Contractor is required to remove signs or other attachments from roadside sign supports or any other structure that is to remain in place, the cost of this shall be incidental to the Contract bid items. This shall include removing signs, vertical supports, sign lighting and arms, and associated hardware from overhead sign structures which are to remain in place.

657.5-METHOD OF MEASUREMENT:

657.5.1-Class B Concrete Footing, Plain: The quantity of work done for Class B Concrete Footing, Plain will be measured in cubic yards, complete in place and accepted, as determined by the dimensions on the Plans or Contract documents, subject to adjustment as provided for in 104.2 and 109.2.

Payment will be made at the contract unit price per cubic yard for "Class B Concrete Footing Plain". Such price will be full compensation for furnishing all labor, materials, and equipment necessary to construct all footings, including staking out footings and stakes for this purpose; excavation for footings regardless of the type of material encountered; constructing and removing forms when required; furnishing, placing, finishing, and curing the concrete; and all other incidentals necessary to complete the work.
657.5.2-Class B Concrete Footing, Reinforced, Roadside: The quantity of work done for Class B Concrete Footing, Reinforced, Roadside will be measured in cubic yards, complete in place and accepted, as determined by the dimensions on the Plans or Contract documents, subject to adjustment as provided for in 104.2 and 109.2.

Payment will be made at the concrete unit price per cubic yard for "Class B Concrete Footing, Reinforced, Roadside". Such price will be full compensation for furnishing all labor, materials, and equipment necessary to construct all footings, including staking out footings and stakes for this purpose; excavation for footings regardless of the type of material encountered; constructing and removing forms; furnishing and installing reinforcing steel, anchor bolts, washers and nuts; furnishing and installing electrical grounding and conduit sleeves when required; furnishing, placing, finishing, and curing the concrete; furnishing and placing grout as required by the Plans; and all other incidentals necessary to complete the work.

657.5.3-Channel Posts: Measurement for payment of "Channel Posts" will be based on the linear feet of steel channel post of each size necessary to complete the work. The length will be the Plan quantity unless otherwise directed by the Engineer.

In cases where a Square Tube Post is used in lieu of a Channel Post specified in the Plans, as required or allowed for by the Standard Details, measurement of the support shall be the same as specified above and payment will be made using the Plan specified Channel Post bid item at the Contract unit price.

In cases where a Breakaway Splice Device is used, the footage within the length of the splice shall not be counted twice in determining the footage to be paid. All material and installation labor costs associated with the Breakaway Splice Device shall be incidental to the Contract bid items.

Payment will be made at the Contract unit price per linear foot for each size of post required by the Plans. For back to back installations the price per linear foot shall include the material and installation labor costs for the stitch hardware. Such price and payment shall be full compensation for furnishing and erecting the posts, and all labor, equipment, tools, materials, and incidentals necessary to complete the work.

657.5.4-Square Tube Supports: Measurement for payment of "Square Tube Supports" will be based on the linear feet of square tube support of each size necessary to complete the work. The length shall be the Plan quantity unless otherwise directed by the Engineer.

Payment will be made at the Contract unit price per linear foot for each size of support required by the Plans. Such price and payment shall be full compensation for furnishing and erecting the supports, and all labor, equipment, tools, materials, and incidentals necessary to complete the work.

657.5.5-Steel Beam Supports: Measurement for payment of "Steel Beam Supports" will be based on the number of linear feet of supports for each size necessary to complete the work. The supports shall be measured from the bottom of the base plate, and along the centerline of the web, to the top of the support. The quantity to be paid for shall include the supports, hinge plate connections including hardware, and the base plate connection including hardware except as noted herein. The length shall be the Plan quantity unless otherwise directed by the Engineer. Lengths will be computed to the nearest 1/2-foot for each installation and the nearest 1-foot for the total length.
In cases where an Omni-Directional Breakaway Device is specified to be used with the assembly, all material and labor costs associated with the device shall be paid for under the provided Omni-Directional Breakaway Device bid item.

Payment will be made at the contract unit price per linear foot of support for each size and shall be full compensation for furnishing and erecting all supports and materials, tools, labor, and equipment necessary to complete the work.

**657.5.6-Pipe Post Supports:** Measurement for payment of "Pipe Post Supports" will be based on the actual number of pipe posts necessary to complete the work. This quantity shall include the supports, arm connections including hardware, and the base plate connection including hardware.

In cases where a pipe post support is to be installed using a Type L Bridge or Retaining Wall Sign Mounting Bracket, all material and labor costs associated with the bracket shall be paid for under the provided Bridge or Retaining Wall Bracket bid item.

Payment will be made at the contract unit price per support and shall be full compensation for furnishing and erecting all supports and materials, tools, labor, and equipment necessary to complete the work.

**657.5.7-Omni-Directional Breakaway Devices:** Measurement for payment of "Omni-Directional Breakaway Devices" will be based on the actual number of devices necessary to complete the work. This shall equate to the total number of individual supports requiring the installation of an Omni-Directional Breakaway Device. The total cost of each device shall include all components of the device including hardware. The number of units paid for shall be the Plan quantity unless otherwise directed by the Engineer.

Payment will be made at the Contract unit price per unit, and shall be full compensation for materials, tools, labor, and equipment necessary to complete the work.

**657.5.8-Back to Back U-Channel Breakaway Devices:** Measurement for payment of "Back to Back U-Channel Breakaway Devices" will be based on the actual number of devices necessary to complete the work. This shall equate to the total number of individual supports requiring the installation of a Back to Back U-Channel Breakaway Device. The total cost of each device shall include all components of the device including hardware. The number of units paid for shall be the Plan quantity unless otherwise directed by the Engineer.

Payment will be made at the Contract unit price per unit, and shall be full compensation for materials, tools, labor, and equipment necessary to complete the work.

**657.5.9-Surface Mount Breakaway Devices:** Measurement for payment of "Surface Mount Breakaway Devices" will be based on the actual number of devices necessary to complete the work. This shall equate to the total number of individual supports requiring the installation of a Surface Mount Breakaway Device. No differentiation in payment shall be made based on differentiation in cost of the device for each different size support. The total cost of each device shall include all components of the device including hardware. The number of units paid for shall be the Plan quantity unless otherwise directed by the Engineer.

Payment will be made at the Contract unit price per unit, and shall be full compensation for materials, tools, labor, and equipment necessary to complete the work.
657.5.10-Bridge, Retaining Wall, and Barrier Wall Brackets: Measurement for payment of “Bridge or Retaining Wall Brackets” and “Barrier Wall Brackets” will be based on the actual number of brackets necessary to complete the work. The total cost of each bracket shall include all components of the bracket including parapet, wall, or barrier connection hardware. With the exception of the Type D Barrier Wall Bracket, the vertical support(s) of each bracket shall be paid for separately under the applicable bid item. The number of units paid for shall be the Plan quantity unless otherwise directed by the Engineer.

Payment will be made at the Contract unit price per unit, and shall be full compensation for materials, tools, labor, and equipment necessary to complete the work.

657.5.11-Support or Bracket Removal: Measurement for payment of "Support or Bracket Removal" will be based on the actual number of supports and/or brackets that are required to be removed. This quantity shall be the Plan quantity unless otherwise directed by the Engineer. In cases where a bracket is designated for removal, any supports attached to the bracket shall not be counted as additional quantities.

Payment will be made at the contract unit price per support or bracket. This price shall also be full compensation for the removal and disposal of the signs and sign assemblies, including hardware and bracing, the removal and disposal of the supports and the restoration of the ground surface to its original condition. No differentiation in payment shall be made based on support size, bracket type, or the method that was originally used to anchor the support.

657.6-BASIS OF PAYMENT:
The quantities, determined as provided, will be paid for at the contract unit price for the items listed below, which prices and payment shall be full compensation for furnishing all the material and doing all the work prescribed in a workmanlike and acceptable manner, including all tools, equipment, supplies and incidentals necessary to complete the work. All incidental work and materials for which no basis of payment is provided will be considered as completely covered by the prices bid for the items included in the Contract.

657.7-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>657005-001</td>
<td>Wood Support,</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657006-001</td>
<td>S4X7.7 Steel Beam Support</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657006-005</td>
<td>W6X12 Steel Beam Support</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657006-010</td>
<td>W8X18 Steel Beam Support</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657006-015</td>
<td>W10X22 Steel Beam Support</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657008-001</td>
<td>2.00 LB Channel Post</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657010-001</td>
<td>3.00 LB Channel Post</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657012-001</td>
<td>4.00 LB Back to Back Channel Post</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657014-001</td>
<td>6.00 LB Back to Back Channel Post</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657016-001</td>
<td>Class B Concrete Footing, Plain, Roadside</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>657017-001</td>
<td>Class B Concrete Footing, Reinforced, Roadside</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>657018-001</td>
<td>Support or Bracket Removal</td>
<td>Each</td>
</tr>
<tr>
<td>657019-001</td>
<td>Pipe Post</td>
<td>Each</td>
</tr>
<tr>
<td>Item Number</td>
<td>Description</td>
<td>Unit</td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------------------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>657035-001</td>
<td>Square Tube Support, 1.75X14GA</td>
<td>Linear Foot</td>
</tr>
<tr>
<td>657040-001</td>
<td>Omni-Directional Breakaway Device</td>
<td>Each</td>
</tr>
<tr>
<td>657041-001</td>
<td>Back to Back U-Channel Breakaway Device</td>
<td>Each</td>
</tr>
<tr>
<td>657042-001</td>
<td>Surface Mount Breakaway Device</td>
<td>Each</td>
</tr>
<tr>
<td>657050-001</td>
<td>Bridge or Retaining Wall Bracket, Type</td>
<td>Each</td>
</tr>
<tr>
<td>657060-001</td>
<td>Barrier Wall Bracket, Type</td>
<td>Each</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 709
METALS

709.51-U-CHANNEL BREAKAWAY MOUNTING DEVICES:

DELETE THE ENTIRE 709.51 SUBSECTION AND REPLACE WITH THE FOLLOWING:

709.51-SURFACE MOUNT SIGN SUPPORT BREAKAWAY DEVICES:

Surface Mount Sign Support Breakaway Devices shall be designed for use with 2-lb/ft and/or 3-lb/ft u-channel supports shown on Standard Details Book Volume II (Standard Details) sheets TE1-7A and TE1-7B, and/or 1-3/4” x 14-gauge Square Tube Supports as described in Section 657. The purpose of the device shall be to create an omni-directional breakaway, low maintenance support installation on asphalt and concrete surfaces which does not require any portion of the support to be installed below grade. The device shall be designed for use with one or more of the support types/sizes specified above. Differences in the dimensioning of components used with each type/size support is permissible.

The device shall be designed and tested to meet the following requirements:

i. Withstand loading which meets or exceeds that which will be generated based on the Support Size Selection Chart on Sheet TE1-7A, as well as cyclical loading, without failure.

ii. Shall be compatible with one or more of the u-channel supports listed on the Division Approved Products List (APL) for U-Channel Posts, and/or square tube support which meet the requirements of Section 709.55.

iii. Shall be designed to be surface mounted on both asphalt and concrete surfaces of nominal minimum thickness. Concrete foundations shall not be required.

iv. Components shall be manufactured using aluminum, stainless steel, galvanized steel, exterior grade epoxy coated steel, or similar material exhibiting weather resistance equal to or greater than those described.

v. Shall not require modification of the support for installation.

vi. Shall be designed to be anchored to the surface and shall not require saw cutting, jackhammering, etc. of the asphalt or concrete.

vii. Shall be acceptable for use with supports of the types/sizes that the device is approved for use with regardless of the number of supports. The manufacturer may
limit the number of supports within a seven 7-foot path when the device is used. However, a minimum of two supports shall be permissible within a 7-foot path.

viii. Allows the support to break away when impacted from any angle.

ix. Minimizes the risk to pedestrians during and after impacts by not incorporating components which become independent projectiles, or which become potentially hazardous shards projecting above grade.

x. No component not designed to breakaway or yield upon impact shall project more than 4-inches above the surface, providing the device is installed flush to the surface in accordance with the manufacturer’s specifications.

xi. May require the replacement of a portion of, or up to all of the system components after impact; however, repair or replacement after impacts shall not be time consuming or labor intensive. The required use of power equipment or expensive, highly specialized equipment to remove damaged components and/or to complete repairs, including instances where the device has been impacted directly by a vehicle tire or undercarriage, shall be unacceptable.

xii. Shall be “crashworthy” when utilized and installed in accordance with the manufacturer’s specifications such as brand supports, maximum number of supports within a 7-foot path, etc., and with traffic signs securely mounted to the supports in accordance with the mounting height guidelines provided on Sheet TP3-1A of the Standard Details.

“Crashworthy”, as specified herein, shall be defined as compliance with the crash testing requirements of National Cooperative Highway Research Program Report 350 (NCHRP-350) Test Levels I, II and III for projects let prior to December 31, 2019, and the crash testing requirements of the AASHTO Manual for Assessing Safety Hardware (MASH) at Test Levels I, II, and III for projects let on or after December 31, 2019.

Mandatory guidelines applying to the device such as, but not limited to, the type/size supports it is permitted to be used with, brand supports it is permitted to be used with, and the maximum number of supports permitted within a seven 7-foot path when the device is used, shall be noted on the APL.

The manufacturer shall supply installation instructions and all required components and hardware to the Contractor. This shall include a complete anchoring system to secure the device to the asphalt or concrete surface. The manufacturer shall make available device installation instructions for posting and dissemination by the Division to inspection and maintenance personnel.

709.51.1-Product Submission and Approval: Surface Mount Breakaway Devices to be considered for inclusion on the Division Roadside Sign Support Accessories APL shall be submitted to the Materials Division following the current procedures specified by the Division in MP 106.00.02. The manufacturer should include all relevant documentation and information, including but not limited to Product Data Sheets, Product Flyers, Manufacturer Product Specifications, Product Bulletins, Engineering Drawings, and crash testing performance documentation. The crash testing performance documentation to be submitted shall be in accordance with official guidance issued by the WVDOH.

In addition to the above, field evaluation installations shall be required prior to approval. In order for the device to be approved, evaluation installations installed by or for the Division
shall demonstrate levels of durability, reliability, performance, and ease of installation/repair determined to be acceptable to Division evaluation personnel. The duration of the field evaluations shall typically be a minimum of six months to one year. Specific details related to this testing, such as locations and quantities, shall be determined by the Division. Initial and typical repair material costs associated with the device shall also be considered as part of the evaluation.

ADD THE FOLLOWING SUBSECTION:

709.52-STEEL BEAM SIGN SUPPORT OMNI-DIRECTIONAL BREAKAWAY DEVICE:

Steel Beam Sign Support Omni-Directional Breakaway Devices shall be designed for use with Steel Beam roadside sign supports shown on Standard Detail Book Volume II (Standard Details) sheets TE1-3A, TE1-3B, and TE1-3C. The purpose of the device shall be to transform the bi-directional slip base breakaway mechanism of Steel Beam supports into an omni-directional breakaway connection. The device may be designed for use with one or more of the standard size Steel Beam supports shown in the Standard Details.

The device shall be designed and tested to meet the following requirements:

i. Withstand loading which meets or exceeds that which will be generated based on the Support Size Selection Chart on Sheet TE1-3B, as well as cyclical loading, without failure.

ii. Components shall be manufactured using aluminum, stainless steel, galvanized steel, exterior grade epoxy coated steel, or similar material exhibiting weather resistance equal to or greater than those described.

iii. Other than elimination of the keeper plate and/or elimination of the standard connection hardware between the support base plate and the stub post base plate, the device shall require no modifications to the design of the support. This shall include the stub post and the support hinge plates.

iv. Shall be acceptable for use with supports of the sizes that the device is approved for use with regardless of the number of supports connected by the sign(s) or bracing above the hinge plates. However, the manufacturer may limit the number of supports within a 7-foot width when the device is used. However, in order to be approved for use with S4x7.7 or W6x12 supports, a minimum of two supports within a 7-foot path shall be permissible.

v. Allow the support to break away from the stub support when impacted from any angle.

vi. Minimizes the risk to pedestrians during and after impacts by not incorporating components which become independent projectiles, or which become potentially hazardous shards projecting above grade.

vii. No component not designed to breakaway or yield upon impact shall project more than ½ inch above the top of the support stub.

viii. May require the replacement of a portion of, or up to all of the system components after impact; however, repair or replacement after impacts shall not be time consuming or labor intensive. The required use of power equipment or expensive, highly specialized equipment to remove damaged components and/or to complete
repairs, including instances where the device has been impacted directly by a vehicle tire or undercarriage, shall be unacceptable.

ix. Shall not affect the support’s compliance with the crash testing requirements of National Cooperative Highway Research Program Report 350 (NCHRP-350) Test Levels I, II and III for projects let prior to December 31st, 2019, and the crash testing requirements of the AASHTO Manual for Assessing Safety Hardware (MASH) at Test Levels I, II, and III for projects let on or after December 31st, 2019. This shall be demonstrable by crash testing performance documentation as described herein.

Mandatory guidelines applying to the device such as, but not limited to, the size supports it is permitted to be used with and the maximum number of supports permitted within a 7-foot span when the device is used, shall be noted on the Approved Products List (APL).

The manufacturer shall supply installation instructions and all required components and hardware to the Contractor. The manufacturer shall make available device installation instructions for posting and dissemination by the Division to inspection and maintenance personnel.

709.52.1-Product Submission and Approval: Omni-Directional Breakaway Devices to be considered for inclusion on the Division Roadside Sign Support Accessories APL shall be submitted to the Materials Division following the current procedures specified by the Division in MP 106.00.02. The manufacturer should include all relevant documentation and information, including but not limited to Product Data Sheets, Product Flyers, Manufacturer Product Specifications, Product Bulletins, Engineering Drawings, and crash testing performance documentation. The crash testing performance documentation to be submitted shall be in accordance with official guidance issued by the WVDOH.

In addition to the above, field evaluation installations shall be required prior to approval. In order for the device to be approved, evaluation installations installed by or for the Division shall demonstrate levels of durability, reliability, performance, and ease of installation/repair determined to be acceptable to Division evaluation personnel. The duration of the field evaluations shall typically be a minimum of six months to one year. Specific details related to this testing, such as locations and quantities, shall be determined by the Division. Initial and typical repair material costs associated with the device shall also be considered as part of the evaluation.

ADD THE FOLLOWING SUBSECTION:

709.53-SQUARE TUBE SIGN SUPPORTS:

Square Tube Sign Supports shall be manufactured of steel conforming to ASTM Specification A653, Designation SS, Grade 50, Class 1, or ASTM Specification A1011, Grade 50. Square tube supports shall be welded at the corner. The supports shall be galvanized per ASTM A653. A minimum coating thickness as indicated by the G90 designation shall be applied. Supports manufactured using base material conforming to the A1011 specification shall meet the Grade 50 physical requirements after the galvanization process.

Support sizes shall be defined by the outside dimensions and wall thickness of the support. The supports shall be available in wall thicknesses of 10-gauge (0.135” U.S.S. Gauge), 12-gauge (0.105” U.S.S. Gauge), and 14-gauge (0.083” U.S.S. Gauge). 10-gauge supports shall be available in 2-3/16 inch and 2-1/2 inch sizes. 12-gauge supports shall be available in 1-1/2 inch through 2-
1/2 inch sizes in ¼-inch increments. 14-gauge supports shall be available in 1-3/4 inch through 2-1/4 inch sizes in ¼-inch increments.

The supports shall be straight and shall have a smooth uniform finish. Each size support shall be telescopic into the next larger size support of the same gauge thickness. In addition, each size support shall be telescopic into the next larger size support of the next thicker gauge size. Supports shall telescope freely and with a minimum amount of play. The supports shall be pre-punched on all four sides on one 1-inch center to center spacing. Holes shall be 3/8-inch (+ 1/16 inch / - 0 inch) diameter after galvanizing.

The manufacturer’s square tube support system shall be “crashworthy” under the following conditions:

i. Supports are driven into strong soil, as defined in National Cooperative Highway Research Program Report 350 (NCHRP-350) or the AASHTO Manual for Assessing Safety Hardware (MASH), as applicable, to the manufacturer recommended depth. Supports shall not be required to be driven more than 30-inches in the soil described.

ii. Supports are either directly driven or with a stub that the upper support is telescopic into as described herein. The upper support shall be telescoped into the stub a distance equal to or greater that which is recommended by the manufacturer.

iii. No limit shall be placed on the total number of supports. However, no more than two supports of size 2-inch x 12-ga. or less shall be placed laterally within a 7-foot wide path; and no more than one support of size 2-1/4-inch x 14 or 12-ga., 2-1/2-inch x 12-ga., or 2-3/16-inch x 10-ga. shall be placed laterally within a 7-foot wide path.

iv. Traffic signs are securely mounted to the supports in accordance with the mounting height guidelines provided on Sheet TP3-1A of the WVDOH Standard Details Book Volume II.

“Crashworthy” shall be defined as compliance with the crash testing requirements of NCHRP-350 Test Levels I, II and III for projects let prior to December 31, 2019, and the crash testing requirements of the AASHTO MASH at Test Levels I, II, and III for projects let on or after December 31, 2019. FHWA eligibility letters, crash testing reports, or other supporting documentation shall be provided upon request.

The manufacturer shall make available installation instructions for posting and dissemination by the Division to inspection and maintenance personnel.

ADD THE FOLLOWING SUBSECTION:

709.54-BACK TO BACK U-CHANNEL SIGN SUPPORT BREAKAWAY DEVICE:

Back to Back U-Channel Sign Support Breakaway Devices shall be designed for use with 4-lb/ft and/or 6-lb/ft back to back supports shown on Standard Detail Book Volume II (Standard Details) sheets TE1-7A and TE1-7B. The purpose of the device shall be to create a omni-directional breakaway base connection. The device shall be designed for use with a stub and upper support of one or both of the back to back size supports specified above. Differences in the dimensioning of components used with each size support is permissible.

The device shall be designed and tested to meet the following requirements:
i. Withstand loading which meets or exceeds that which will be generated based on the Support Size Selection Chart on Sheet TE1-7A, as well as cyclical loading, without failure.

ii. Shall be compatible with one or more of the supports listed on the Division Approved Products List (APL) for U-Channel Posts.

iii. Shall function with the stub support installed in a concrete foundation as shown on Standard Detail Sheet TE1-7B.

iv. Components shall be manufactured using aluminum, stainless steel, galvanized steel, exterior grade epoxy coated steel, or similar material exhibiting weather resistance equal to or greater than those described.

v. Shall not require modification of the stub or upper support for installation.

vi. Shall be acceptable for use with supports of the sizes that the device is approved for use with regardless of the number of supports. The manufacturer may limit the number of supports within a seven 7-foot width when the device is used. However, a minimum of two 4-lb/ft or 6-lb/ft back to back supports within a 7-foot width shall be permissible.

vii. Allows the upper support to break away from the stub support when impacted from any angle.

viii. Minimizes the risk to pedestrians during and after impacts by not incorporating components which become independent projectiles, or which become potentially hazardous shards projecting above grade.

ix. Shall allow for installation after concrete is placed around the stub to grade.

x. No component not designed to breakaway or yield upon impact shall project more than 4-inches above ground level, providing the projection of the stub support is in accordance with the manufacturer’s recommendations.

xi. May require the replacement of a portion of, or up to all of the system components after impact; however, repair or replacement after impacts shall not be time consuming or labor intensive. The required use of power equipment or expensive, highly specialized equipment to remove damaged components and/or to complete repairs, including instances where the device has been impacted directly by a vehicle tire or undercarriage, shall be unacceptable.

xii. Shall be “crashworthy” when utilized and installed in accordance with the manufacturer’s recommendations such as brand supports, size supports, maximum number of supports permitted within a 7-foot width, etc., and with traffic signs securely mounted to the supports in accordance with the mounting height guidelines provided on Sheet TP3-1A of the Standard Details.

“Crashworthy”, as specified herein, shall be defined as compliance with the crash testing requirements of National Cooperative Highway Research Program Report 350 (NCHRP-350) Test Levels I, II and III for projects let prior to December 31st 2019, and the crash testing requirements of the AASHTO Manual for Assessing Safety Hardware (MASH) at Test Levels I, II, and III for projects let on or after December 31st 2019.

Mandatory guidelines applying to the device such as, but not limited to, the size supports it is permitted to be used with, brand supports it is permitted to be used with, and the maximum number of supports permitted within a 7-foot path shall be noted on the APL.
The manufacturer shall supply installation instructions and all required components and hardware to the Contractor. The manufacturer shall make available device installation instructions for posting and dissemination by the Division to inspection and maintenance personnel.

709.54.1-Product Submission and Approval: Back to Back U-Channel Breakaway Devices to be considered for inclusion on the Division Roadside Sign Support Accessories APL shall be submitted to the Materials Division following the current procedures specified by the Division in MP 106.00.02. The manufacturer should include all relevant documentation and information, including but not limited to Product Data Sheets, Product Flyers, Manufacturer Product Specifications, Product Bulletins, Engineering Drawings, and crash testing performance documentation. The crash testing performance documentation to be submitted shall be in accordance with official guidance issued by the WVDOH.

In addition to the above, field evaluation installations shall be required prior to approval. In order for the device to be approved, evaluation installations installed by or for the Division shall demonstrate levels of durability, reliability, performance, and ease of installation/repair determined to be acceptable to Division evaluation personnel. The duration of the field evaluations shall typically be a minimum of six months to one year. Specific details related to this testing, such as locations and quantities, shall be determined by the Division. Initial and typical repair material costs associated with the device shall also be considered as part of the evaluation.

ADD THE FOLLOWING SUBSECTION:

709.55-TYPE A AND B BARRIER WALL SIGN SUPPORT BRACKETS:

Type A and B Barrier Wall Sign Support Brackets (Type A and B Brackets) shall be designed for use with 1-3/4” x 14-gauge Square Tube Supports meeting the requirements of Section 709.55. The purpose of the device shall be for mounting specified sign assemblies on top of a median barrier wall or parapet.

The brackets shall be designed and tested to meet the following requirements:

i. Type A Brackets and anchoring shall withstand loading which meets or exceeds that which will be generated based on the Support Size Selection Chart on Sheet TE1-7A for the 3-lb/ft u-channel support size, as well as cyclical loading, without failure. The bracket shall meet this requirement with the bracket installed on a 6-inch wide, non-tapered, unreinforced barrier manufactured with concrete meeting a design strength of 3,000-PSI.

ii. Type A Brackets shall be permitted to include side anchors on one or both faces of the barrier. However, the bracket shall not extend more than 4-inches down the face of the barrier. When installed on a barrier with no taper, the bracket shall not extend more than 3/8-inch from the face of the barrier. This requirement does not include the bracket side anchors. However, the anchoring system supplied by the manufacturer for the side anchors shall utilize domed head bolts to minimize the potential for snagging.

iii. Type A Brackets shall be designed such that upon final installation as designed, it shall be possible to install the square tube support at the centerline of the wall. The bracket shall meet this requirement when installed on barriers with the following characteristics:
a. Barrier width at the top is a minimum of 6-inches and is less than 10-inches. Taper on one or both faces of the barrier is as little as 0-inches per foot of height to as much as 1-1/4-inches per foot of height.

b. Barrier width at the top is a minimum of 6-inches and is 8-inches or less. Taper on one or both faces of the barrier is greater than 1-1/4-inches per foot of height and as much as 2-3/4-inches per foot of height.

iv. Type B Brackets and anchoring shall withstand loading which meets or exceeds that which will be generated based on the Support Size Selection Chart on Sheet TE1-7A for the 3-lb/ft u-channel support size, as well as cyclical loading, without failure. The bracket shall meet this requirement with the bracket installed on a 10-inch wide, non-tapered, unreinforced barrier manufactured with concrete meeting a design strength of 3,000 PSI.

v. Type B brackets shall not incorporate side anchors. All anchoring shall be vertical and no components of the bracket shall extend below the top of the wall.

vi. The width (portion on top of the wall) and length of Type A and B brackets shall not exceed 7-inches.

vii. Type A and B bracket components shall be manufactured using galvanized steel, exterior grade epoxy coated steel, or similar material exhibiting weather resistance equal to or greater than those described. This shall include the bracket and the anchoring system.

viii. Type A and B brackets shall not require modification of the support for installation.

ix. Type A and B brackets shall minimize the risk to motorists and pedestrians during and after impacts by not incorporating components which become independent projectiles.

The manufacturer shall supply installation instructions and all required components and hardware to the Contractor. This shall include the complete system to be used for anchoring the brackets as well as hardware for securing the square tube support to the bracket. The manufacturer shall make available device installation instructions for posting and dissemination by the Division to inspection and maintenance personnel.

**709.55.1-Product Submission and Approval:** Type A and B Brackets to be considered for inclusion on the Division Roadside Sign Support Accessories APL shall be submitted to the Materials Division following the current procedures specified by the Division in MP 106.00.02. The manufacturer should include all relevant documentation and information, including but not limited to Product Data Sheets, Product Flyers, Manufacturer Product Specifications, Product Bulletins, and Engineering Drawings.

In addition to the above, field evaluation installations shall typically be required prior to approval. In order for the device to be approved, evaluation installations installed by or for the Division shall demonstrate levels of durability, reliability, performance, and ease of installation/repair determined to be acceptable to Division evaluation personnel. The duration of the field evaluations shall typically be a minimum of six months to one year. Specific details related to this testing, such as locations and quantities, shall be determined by the Division.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 658
OVERHEAD SIGN STRUCTURES

658.1-DESCRIPTION:

DELETE THE CONTENTS OF SUBSECTION 658.1 AND REPLACE WITH THE FOLLOWING:

This item shall consist of the fabrication and erection of overhead frame, cantilever, butterfly, and span structure sign supports and fastening accessories in accordance with the requirements of the Plans and of these Specifications. All details not specified or not shown on the Plans shall conform to the details and requirements set forth in the following Specifications and publications:

i. West Virginia Department of Transportation, Division of Highways, Standard Details Book Vol. II, Signing, Signals, Lighting, Markings, and ITS, latest issue, including revisions (further referenced to herein as the Standard Details).

ii. The Manual on Uniform Traffic Control Devices for Streets and Highways, latest issue, as printed by the Federal Highway Administration, U.S. Department of Transportation (Referred to as the MUTCD).


All material, fabrication, and installation requirements for overhead frame structures shall be included in the project Plans and shop drawings.

658.2-MATERIALS:

DELETE THE CONTENTS OF SUBSECTION 658.2 AND REPLACE WITH THE FOLLOWING:

Materials furnished shall be of new stock conforming to the requirements of the Specifications, and shall meet the approval of the Engineer.
658.2.1-Pipe: Non-tapered steel pipe used for arms, chords, support legs, and bracing shown on various Standard Detail sheets shall be seamless or welded pipe conforming to ASTM A 501 or ASTM A 53, Type E or S, Grade B. Galvanized in accordance with ASTM A123.

Non-tapered aluminum pipe used for chords and bracing shown on Standard Detail sheets TE5-1A and TE5-1B shall conform to ASTM B221, ASTM B429, or ASTM B241, all Alloy 6061, temper T6.

Tapered steel pipe used for arms and support legs shown on Standard Detail sheets TE4-4A and TE4-4B shall be manufactured from steel having a min. yield strength of 55,000 PSI after fabrication. Galvanized in accordance with ASTM A123.

658.2.2-Plate: Flat steel plate used for chord plates, base plates, arm end plates, arm splice plates, and box flange plates shown on various Standard Detail sheets shall conform to ASTM A 572, Grade 42. Galvanized in accordance to ASTM A 123.

Flat steel plate used for gusset plates, saddle plates, hand hole plates, and stiffener plate shown on various Standard Detail sheets shall conform to ASTM A 36. Galvanized in accordance to ASTM A 123.

Flat aluminum plate used for gusset plates and chord plates shown on Standard Detail sheets TE5-1A and TE5-1B shall conform to ASTM B209, Alloy 6061, temper T6.

658.2.3-Structural Connection Bolt: Carbon steel structural connection bolts and associated hardware shown on various Standard Detail sheets shall conform to the following requirements. Bolts: ASTM F3125 Grade A325, Type I. Nuts: ASTM A563, Grade DH with lubricant contrasting with the color of the galvanizing. Washers: ASTM F436, Type I. All galvanized in accordance to ASTM B695.

Stainless steel structural connection bolts and associated hardware to be used for connecting aluminum chord plates as shown on Standard Detail sheets TE5-1A and TE5-1B shall conform to the following requirements. Bolts: ASTM F593 Condition CW2. Nuts: ASTM F594 Condition CW2. Washers: ASME B18.21.1 lock washers. All Alloy 316.

658.2.4-Friction Caps: Steel friction caps shown on various Standard Detail sheets shall conform to ASTM A653, designation CS, and shall be zinc electrodeposited coated in accordance with ASTM B633, Class 12.

Aluminum friction caps shown on Standard Detail sheets TE5-1A and TE5-1B shall conform to ASTM B26, Alloy 356, temper F.

658.2.5-Structural Shapes: Steel W10x77 beams as shown on Standard Detail sheets TE3-1 and TE3-2 shall be standard wide flange shapes fabricated from steel conforming to ASTM A36 or ASTM A572 Grade 50. Steel conforming to ASTM A992 and dual certified to ASTM A572 Grade 50 may also be used. The beams shall be galvanized in accordance with ASTM A123.

Steel WT8x25 tees as shown on Standard Detail sheets TE5-1A and TE5-1B shall be standard WT shapes fabricated from steel conforming to ASTM A36 or ASTM A572 Grade 50. Steel conforming to ASTM A992 and dual certified to ASTM A572 Grade 50 may also be used. The tees shall be galvanized in accordance with ASTM A123.
658.2.6-U-Bolts: Carbon steel u-bolts and associated hardware shown on various Standard Detail sheets shall conform to the following requirements: Bolts: ASTM A307 Grade A. Nuts: ASTM A563A Hex. Flat washers: ASTM F844. All galvanized in accordance to ASTM F2329.

Stainless steel u-bolts and associated hardware to be used with aluminum chords as shown on Standard Detail sheets TE5-1A and TE5-1B shall conform to the following requirements: Bolts: ASTM F593 Condition CW2. Nuts: ASTM F594 Condition CW2. Washers: ASME B18.21.1 lock washers. All Alloy 316.

658.2.7-Anchor Bolts: Steel anchor bolts and associated hardware shown on various Standard Detail sheets shall conform to the following requirements: Bolts: ASTM F1554 Grade 55. Nuts: ASTM F563 Grade A. Washers: ASTM F436. All galvanized in accordance with ASTM B695.

658.2.8-Concrete: All concrete shall be Class B in accordance with Section 601.

658.2.9-Reinforcing Steel: All reinforcing steel shall be meet the requirements of Section 602.

658.5-ERECTION:

DELETE THE CONTENTS OF SUBSECTION 658.5 AND REPLACE WITH THE FOLLOWING:

658.5.1-General: All structures shall be installed at the points designated on the Plans or by the Engineer in accordance with these specifications, the Plans, and approved shop drawings and shall be erected in reasonably close conformity to the locations, elevations, and angles shown on the Plans or established by the Engineer.

Erection of sign structures shall be in accordance with the applicable provisions of the current edition of the Standard Specifications and the requirements given below. The Contractor shall provide all tools, equipment and appliances necessary for the expeditious handling of the work, all of which shall be subject to the approval of the Engineer. Materials and workmanship not previously inspected will be inspected on the site of the work and all rejected material shall be removed from the site of the work.

The Contractor shall take full responsibility for checking all cross sections at approved structure locations to determine final support lengths. Necessary support lengths shall be determined in accordance with the roadway overhead clearance requirements shown in the Plans or Standard Details.

Before proceeding further, the Contractor shall initially establish the location of each structure in accordance with the Plans or as directed by the Engineer and shall mark each site with construction stakes. The Contractor shall furnish stakes, paint, other materials, and labor for performing the locating and staking as described. When the sites have been staked and are ready for inspection, the Contractor shall inform the Engineer, who will check and approve the site or make necessary changes. Centerline station information will be furnished to the Contractor by the Engineer.
All existing or proposed assembly locations are approximate. In cases where an existing assembly, including supports, is to be removed and replaced with a new assembly, the new assembly shall be located as close as possible to the original with a minimum of 20-feet of clearance between the existing foundation and the new foundation unless otherwise approved by the Engineer.

658.5.2-Excavation: The Contractor shall perform excavations for each concrete foundation to the depths and dimensions shown on the Plans. The excavation shall be made in accordance with the applicable provisions of the Standard Specifications.

The Contractor shall contact WV 811 and shall notify all applicable WV 811 non-participating utilities prior to beginning excavation or conduit jacking activities. The Contractor shall hand dig to locate lines or open cut in areas of possible conflict, as determined by the Engineer. The Contractor shall also be responsible for locating and verifying Division owned underground conduit to avoid conflict or damage. All such work shall be incidental to the Contract bid items. All costs associated with any disruption of services as a result of the Contractor’s activities shall be the Contractor’s sole responsibility.

Earth augers, if used shall be of the same diameter as the footings. Where a trench is required, it shall be only as wide and long as is necessary to accommodate the work.

If rock or boulders are encountered during the excavation, they shall be removed to a depth sufficient, in the judgement of the Engineer, to obtain the stability necessary to support the sign structure. The Standard Detail drawings are compiled on the basis of average soil conditions. Soil conditions surrounding specific foundations may require larger foundations. The Contractor shall adjust the foundation dimensions if directed to do so by the Engineer. Any work in such cases shall be performed without change in the unit bid price.

If a foundation is to be installed within the area of an existing concrete or asphalt surface, the concrete or asphalt shall be carefully opened by drilling, saw cutting, or other suitable methods approved by the Engineer that will not cause unnecessary damage to the surrounding surface.

The Contractor shall remove all excavated material from the site that is not needed for backfill or, if permitted by the Engineer, shall spread this material out in the area immediately surrounding the foundation location to the satisfaction of the Engineer. The Contractor shall restore all disturbed areas to within reasonable conformity of their original conditions by grading, seeding, mulching, and/or fertilizing as directed by the Engineer. These operations and required materials shall be paid for incidental to the Contract bid items.

658.5.3-Conduit and Ground Rods: All overhead sign structures shall have conduit and ground rods, regardless of whether they have sign lighting or other electrical components.

A 2-inch diameter galvanized conduit shall be furnished and installed in the support foundations at locations as specified on the Plans. The conduit shall terminate above the top of the foundation and shall be fitted with a 2-inch capped grounding bushing above the foundation. The lower end of the conduit shall emerge from the side of the footing to be joined to conduit from the junction box.

Ground rods shall be copper clad steel, 3/4- inches in diameter with a minimum length as noted on the Plans and shall be one piece. Sectional or segmented ground rods are not permitted. The ground rods shall be complete with ground clamp and square head bolt.
658.5.4-Foundation Placement: The foundations shall be of Class B concrete, reinforced, of the types shown on the Plans. Steel reinforcement, anchor bolts and conduit for the footings shall be as shown on the Plans.

All concrete for each foundation shall be placed in one placement with no construction joints.

Each foundation shall typically be installed with a pedestal as shown on the Standard Details. All pedestals shall be square to a depth of 6-inches minimum below ground level. Each of the two pedestals on each end of box truss span structures shall be constructed at the same elevation. For foundations which are within or project into a concrete or asphalt surface utilized by pedestrians, Americans with Disabilities Act (ADA) walkway specification requirements shall be met as directed by the Engineer. In such cases, the following guidelines shall be followed:

i. Unless unachievable due to right of way restrictions, the foundation shall be placed such that a 48-inch minimum wide walkway is maintained from the edge of the foundation to the roadside edge of the walkway. This measurement shall not include curbs constructed with a joint separating the curb and walkway.

ii. If it is not possible to maintain a 48-inch wide walkway, the pedestal portion of the foundation above grade shall be eliminated, and the top of the foundation shall be constructed flush with the walkway. In this case, the width of the walkway shall be measured from the roadside edge of the structure base plate to the roadside edge of the walkway. This measurement shall not include curbs constructed with a joint separating the curb and walkway. This measurement shall not be restricted to less than 32-inches, and the continuous longitudinal length over which the walkway is restricted to less than 48-inches shall be for no more than twenty-four 24-inches. The width of the restriction shall be minimized as much as possible within the available right of way.

The anchor bolts shall be set accurately by means of a template in the position shown on the drawings and held rigidly in the forms so as to avoid displacement during the placement of concrete. The steel reinforcement and conduit shall be properly placed and secured before the placement of concrete. The Contractor shall make periodic checks of the bolt positions and elevations during concrete placement operations. It is essential that the distance between the centers of anchor bolt groups of the two foundations of a span structure be exactly the span lengths shown on the Plans.

The exposed surfaces of all foundations constructed with pedestals as shown in the Standard Details shall be given a Class 1, ordinary finish as defined in Section 601.

658.5.5-Backfilling: If any backfilling is required, excavations shall be backfilled with random material, approved by the Engineer, in horizontal layers not to exceed 4-inches after compaction. Each lift shall be compacted to the satisfaction of the Engineer. Testing is not required.

All surplus material shall be removed from the right-of-way and the backfill finished flush with surrounding natural ground, including replacement of any damaged facilities or appurtenances. The Contractor shall restore all areas disturbed by this excavation or other operations within reasonable conformity to their original conditions including grading, seeding, mulching and/or fertilizing as directed by the Engineer. No separate payment will be made for backfilling materials or operations.
658.5.6-Structure Installation:

658.5.6.1-General: All structures depicted in the Standard Details shall have the support legs installed with the anchor bolts fully tightened before installation of the arms or chords.

The individual sections of any box truss span structure made up of multiple sections shall be spliced together for the full length of one span before lifting into place. In addition, all sign panels, lighting and other accessories required thereon, as described elsewhere in the Standard Specifications, shall be fully installed before lifting the box truss into place.

Two-Tube-Span and One-Tube-Span structures as shown on Standard Detail sheets TE3-1 and TE3-2 shall have the entire span assembled and fully tightened before lifting the span into place. The arm splice connections of Heavy Single Arm Cantilevers and Light Single Arm Cantilevers as shown on Standard Detail sheets TE4-4A and TE4-4B may be assembled after lifting the section attaching to the support leg into place and fully tightening the structural connection bolts.

The field assembling of the component parts of a structure shall be done in a manner not likely to produce damage by twisting, bending, or otherwise deforming the metal. Signs required to be installed prior to erection or immediately after erection as described herein shall be covered in a manner approved by the Engineer if determined to be necessary due to operational considerations.

658.5.6.2-Installation Preparation: Proper condition and lubrication of hardware associated with anchor bolts and structural bolted connections is critical to proper installation. Only un-weathered hardware components in new condition shall be used. Fastener components shall be protected from dirt and moisture in closed containers at the site of installation. Fastener components shall not be cleaned of lubricant that is present in the as delivered condition. Components that accumulate rust or dirt resulting from plant or job-site conditions shall not be incorporated into the work. Galvanized bolts that have been fully pretensioned shall not be reused.

All nuts shall be pre-coated with a lubricant as specified herein. Prior to snug tightening of any nuts or bolts, lubricant shall be applied to the bolt threads if the threads of the bolts have not been lubricated, were last lubricated more than twenty-four (24) hours prior, or have gotten wet since they were last lubricated. Beeswax or toilet ring wax may be used. If the bolt heads are turned in order to tighten a connection, the Contractor shall apply lubricant to the face of the washer that the bottom of the bolt head is to be tightened against. If pre-coated nuts have gotten wet, lubricant shall be reapplied to the threads and the bearing surface face of the nut.

Prior to erection, the following steps shall be taken by the Contractor:

1. Inspect the separate components of the structure for bent or damaged members, damaged coatings, distortion, blemishes, scratches, cracks, and defective fabrication that would affect proper erection, durability, or structure performance. Localized defects in the galvanizing coating shall be repaired in accordance with the requirements of ASTM A780. Any member slightly bent or twisted shall have all defects corrected in an approved manner before being placed. The Engineer may direct the Contractor to not proceed with the erection of any structure if any serious defects warranting further assessment and possible rejection are found.
2. Verify that there will be no potential fit-up problems when the components of the structure are assembled. Insure connecting plates will fit with no burrs or other seating inhibitors. If more than 25-percent of the surface area of the face of a flange bolted to the face of another component, or surface area of the underside of a structural bolt head or nut, is visible after snugging of the bolts this shall be cause for rejection.

3. Apply protective coating materials if aluminum components are to be attached to concrete, masonry, or steel if the steel is neither galvanized nor stainless. If to be attached to steel which is neither galvanized nor stainless, the aluminum points of contact shall be coated with a zinc chromate primer or as called for on the Plans, and the steel shall be coated at the points of contact with a suitable priming paint followed by a coat of aluminum paint. If to be attached to concrete or masonry, the points of contact shall be coated with a heavy coat of an alkali-resistant bituminous paint.

4. Verify that the foundations are set to the proper elevation and anchor bolts are set in the correct pattern and orientation, are of the correct size, and are plumb with the specified extension and thread length above the top of concrete.

5. Just prior to erection, the aluminum shall be thoroughly cleaned, and any accumulations of oil, grease, dirt or foreign materials shall be removed using an approved solvent cleaner.

658.5.6.3-Installation Procedure: The following steps shall be followed during the erection procedure:

1. Clean the anchor bolts with a wire brush or equivalent and lubricate the anchor bolts as described herein if this has not already been done.

2. Place and level the foundation leveling nuts with washers on top. Initial placement of the leveling nuts shall be no more than 1/4-inch above the top of the foundation.

3. Bring the support leg(s) into position for placement. Insure anchor bolts and the bolt holes in base plate are properly aligned. No cold working of the anchor bolts shall be allowed. No cutting or reaming of holes will be allowed without prior approval from the Traffic Engineering Division.

4. Place the support leg(s). The Contractor shall take due care to avoid damaging the anchor bolt threads during this process. If the structure has multiple support legs, one support leg shall be placed and fully tightened into place at a time.

5. With the support leg as plumb as possible, adjust the leveling nuts as needed. The gap between the top of concrete and the bottom of each leveling nut shall not exceed the diameter of the anchor bolt after this process is completed.

6. Place top washers and nuts. Snug tighten the top nuts, followed by the leveling nuts. Each set of nuts shall be snug tightened in a star pattern. Snug tightness is considered to be the tightness which exists due to the full effort of a man using a spud wrench with the appropriate length handle for the bolt being tightened. The handle length used for bolts 3/4-inch to 1-1/4-inches in diameter shall be 23-inches. The handle length used for bolts 1-1/2-inches to 2-1/4-inches in diameter shall be 36-inches.
7. Fully tighten the anchor bolts following the procedure described in Section 658.5.6.3.1.

8. Release any load by crane or other erection device. The anchor bolt nuts must be properly tightened before removal of the crane. If problems exist such as the anchor connections are loose after release, then repeat the nut tightening procedure.

9. Lift the structure arms or span into place. The Contractor shall be responsible for determining and selecting appropriate lift points in order to not overstress the structural components or attachments during lifting.

10. Once components that are attached using structural connection bolts are lifted into place and lubrication is applied to the hardware components as required, the bolts shall be snug tightened and then fully tightened immediately. The snug tightening procedure used shall be the same as described for the anchor bolts above under item number 6, except in the case of stainless steel bolts used for the truss of aluminum box trusses. For stainless steel bolts, the amount of torque to be applied during snug tightening shall be limited to that which is required to compress the fastener lock washer. The procedure for fully tightening the bolts is described in Section 658.5.6.3.2. Once span structures are lifted into place and proper alignment is verified, they shall be secured to the support legs by installing and tightening the u-bolts immediately.

11. Check structure. If problems exist, such as loose arm connections or showing gaps, the load must be removed from the area in question and steps repeated as necessary. If this requires loosening structural connection bolts that have already been fully tightened, the bolts shall be replaced.

12. If not installed prior to lifting the arms or chords into place (required for box truss spans), all signs to be attached to the structure arms or chords shall be installed immediately after the attachment hardware for the arms or chords are fully tightened.

658.5.6.3.1-Anchor Bolt Tightening: After snug tightening has been accomplished, the following procedure shall be followed for fully tightening anchor bolts:

1. Verify that all nuts and washers were brought into firm contact with the base plate. Beveled washers may be necessary under the leveling or top nut if any face of the base plate has a slope greater than 1:20 and/or any nut could not be brought into firm contact. If it is determined that beveled washers are required, the support leg shall be disassembled from the anchor bolts and the erection procedure shall be restarted as described in Section 658.5.6.3 using the beveled washers. Beveled washers shall be manufactured of the same material as the base plate and shall be galvanized. Beveled washers shall be square with the length of each side being equal to or greater than the diameter of the normal washers. The minimum thickness of the beveled washers shall be the thickness of the normal washers.

2. Before tightening, at each bolt location the reference position of the top nut in the snug-tight condition shall be marked with a suitable marking on one flat with a corresponding reference mark on the base plate.
3. Top nuts shall be turned in increments and in a star pattern over at least two full tightening cycles, meaning the rotation applied to each nut during each cycle shall be approximately half the amount described herein. Nut rotation shall be 1/3 of a turn for bolts 1-1/2 inches in diameter or less and shall be 1/6 of a turn for bolts greater than 1-1/2 inches in diameter. The amount of torque required to fully tighten each nut shall be recorded for use in steps 4 and 5. After tightening, the nut rotation shall be verified. The wrench used shall be a hydraulic torque wrench with sufficient capacity for the bolts to be tightened, and with the capability of loosening. Prior to tightening any fasteners, the Contractor shall provide the Engineer with a copy of calibration certificates for the hydraulic wrench. Separate calibration certificates are required for each wrench and for the gauge associated with each power pack to be used on the project. The date of the calibrations shall be one year or less prior to the advertising date of the Contract. The certificate provided shall be from a calibration lab that is International Organization for Standardization (ISO) 17025 accredited, with the certificate indicating as such. Both the certificate and wrench or gauge shall display matching serial numbers.

4. The same hydraulic torque wrench and power pack combination which was used to fully tighten the anchor bolts shall be used to verify that a torque at least equal to the torque value given by the following equation is required to additionally tighten the leveling nuts and the top nuts. If the required torque is less, this should be interpreted to indicate that the threads have stripped and should be reported to the Traffic Engineering Division.

\[ T_v = 0.12 \, (D_b) \, F_i \]

Where:

- \( T_v \) = verification torque (inch-kips)
- \( D_b \) = nominal body diameter of the anchor bolt (inches)
- \( F_i \) = 60% of the anchor bolt minimum tensile strength (kips) (= 45 ksi for ASTM F1554 Grade 55)

Multiply \( T_v \) by 83.3 to calculate \( T_v \) in ft-lbs

5. After at least 48-hours, the same hydraulic torque wrench and power pack combination which was used to fully tighten the anchor bolts shall be used to verify that a torque at least equal to 1.10 \( T_v \) is required to additionally tighten the leveling nuts and the top nuts. If the required torque is less, this should be interpreted to indicate that the threads have stripped and should be reported to the Traffic Engineering Division.

658.5.6.3.2-Structural Connection Bolt Tightening: After snug tightening has been accomplished, the following procedure shall be followed for fully tightening structural connection bolts:

1. For galvanized carbon steel structural connection bolts, apply the appropriate rotation to the turning elements in the same sequence as snug tightening. Rotation shall be in accordance with Table 615.5.6.3 B. Full tightening of each
bolt shall be accomplished in approximately 10- seconds using a hydraulic
torque wrench meeting the requirements specified herein, or impact wrenches
of adequate capacity.
2. For stainless steel structural connection bolts, apply the appropriate torque to
the turning elements in the same sequence as snug tightening. Full tightening
of each bolt shall be accomplished using a manual click type torque wrench
meeting the requirements of Section 657. Before tightening, the Contractor
shall provide the Engineer with a copy of the required calibration certificate.
The torque applied shall be in accordance with Table 658.5.6.3.2.

<table>
<thead>
<tr>
<th>Bolt Size (in)</th>
<th>Torque (ft-lb)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>½</td>
<td>45</td>
</tr>
<tr>
<td>5/8</td>
<td>97</td>
</tr>
<tr>
<td>¾</td>
<td>132</td>
</tr>
<tr>
<td>7/8</td>
<td>202</td>
</tr>
<tr>
<td>1</td>
<td>300</td>
</tr>
</tbody>
</table>

*Based on Alloy 316

658.8-PAY ITEMS:

REPLACE THIS SECTION WITH THE FOLLOWING:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>658001-*</td>
<td>Class B Concrete Footings, Reinforced, Overhead</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>658005-*</td>
<td>Overhead Sign, Two Tube Span</td>
<td>Each</td>
</tr>
<tr>
<td>658006-*</td>
<td>Overhead Sign, One Tube Span</td>
<td>Each</td>
</tr>
<tr>
<td>658007-*</td>
<td>Overhead Sign, Double Arm Cantilever</td>
<td>Each</td>
</tr>
<tr>
<td>658008-*</td>
<td>Overhead Sign, Butterfly Cantilever</td>
<td>Each</td>
</tr>
<tr>
<td>658009-*</td>
<td>Overhead Sign, Single Arm Cantilever (Heavy)</td>
<td>Each</td>
</tr>
<tr>
<td>658010-*</td>
<td>Overhead Sign, Single Arm Cantilever (Light)</td>
<td>Each</td>
</tr>
<tr>
<td>658011-*</td>
<td>Overhead Sign, Steel Box Truss Span</td>
<td>Each</td>
</tr>
<tr>
<td>658012-*</td>
<td>Overhead Sign, Aluminum Box Truss Span</td>
<td>Each</td>
</tr>
<tr>
<td>658013-*</td>
<td>Overhead Sign, Frame</td>
<td>Each</td>
</tr>
</tbody>
</table>

* Sequence Number
DELETE THE ENTIRE SECTION AND REPLACE WITH THE FOLLOWING:

661.1-DESCRIPTION:
This item shall consist of the fabricating, furnishing, and erecting of a complete system of traffic signs and delineators in accordance with the requirements of the Plans and of these specifications. All details not specified or not shown on the Plans shall conform to the details and requirements set forth in the following specifications and publications:

i. West Virginia Department of Transportation, Division of Highways, Standard Details Book Vol. II, Signing, Signals, Lighting, Markings, and ITS, latest issue, including revisions (further referenced to herein as the Standard Details).

ii. West Virginia Division of Highways, Sign Fabrication Details, latest issue, including revisions (further referenced to herein as the Fabrication Manual).


iv. The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), latest issue, as printed by the Federal Highway Administration, U.S. Department of Transportation.

v. Standard Alphabets for Highway Signs, latest issue, as printed by the Federal Highway Administration, U.S. Department of Transportation.

661.2-MATERIALS:
The criteria for sampling, inspection, and acceptance of signing materials are documented in MP 661.02.40.

Materials furnished shall be of new stock conforming to the requirements of the Specifications and shall meet the approval of the Engineer.

661.2.1-Flat Sheet Aluminum Substrate: Flat sheet aluminum substrate for flat sheet signs, reflective post strips, XS-1 delineators, demountable copy, demountable border, and sign shims shall be either Alloy 6061 T6 or 5052 H38 per ASTM B209. Material shall meet the ASD fabrication requirements for mill products.
The surface of blanks to which sheeting is to be applied shall be degreased and etched in accordance with the sheeting manufacturer’s recommendations. All blank exposed surfaces shall be given a chromate type chemical conversion treatment conforming to ASTM B449 Class I or Class II.

Blanks shall be free of buckles, warp, dents, and burrs prior to the application of reflective sheeting or other background material. Dimples or indentations shall not be noticeable from a distance of 10-feet normal to the panel.

With the exception of XS-15 signs and demountable copy, borders, and shields riveted to the faces of extruded panel signs, all flat sheet aluminum for the items described above shall be 0.080 inches thick. For the exceptions specified above, the material shall be 0.040 inches thick.

661.2.2-Extruded Panel Substrate: Extruded panel substrate for extruded sign panels shall be Alloy 6063 T6 per ASTM B221.

The surface of panels to which sheeting is to be applied shall be degreased and etched in accordance with the sheeting manufacturer’s recommendations. All panel exposed surfaces shall be given a chromate type chemical conversion treatment conforming to ASTM B449 Class I or Class II.

Cross sectional dimensioning of extruded sign panels should be per the details provided on Standard Detail sheet TE7-1, within the established commercial tolerances of the aluminum industry. An alternate extruded panel section of equal or greater section modulus and having dimensions suitable to utilize the hardware shown on sheet TE7-1 may be supplied by the Contractor with written approval of the Engineer.

Each panel shall be flat and true within 1/4-inch tolerance on an 8-foot length, with proportionately greater allowance on longer lengths. Flatness across the face of each panel shall be limited to 0.004 inches per inch of width.

661.2.3-Retroreflective Sheeting and Matched Components: Retroreflective sheeting and matched components used on flat sheet signs, extruded panel signs, delineators, reflective sign support strips, and all other products requiring such shall meet the requirements of 715.9.2.

Fluorescent-yellow Type ASTM-XI sheeting shall be used when fabricating the following signs: W1-6 through W1-8, all 48-inch diamond W Series, all W Series supplemental plaques installed below a 48-inch diamond W Series, all XR Series, all XS Series, all yellow panels of extruded panel signs, any yellow flat sheet sign attached to a yellow extruded panel sign background, and any other signs designated in the Plans to have a fluorescent-yellow background.

Fluorescent-yellow-green Type ASTM-XI sheeting shall be used when fabricating the following signs: all S Series requiring a yellow background and any other signs designated in the Plans to have a fluorescent-yellow-green background.

Sheeting for extruded panel sign demountable copy, border, and shields shall be Type ASTM-XI.

Unless specified otherwise in the Plans, all other sheeting for signs shall be Type ASTM-IV. Sheetings to be utilized with other devices shall be as specified herein.

Nylon washers, if required, shall be manufactured of commercial grade nylon. Nylon washers for use with 5/16-inch bolts shall have an outside diameter of 7/8-inch.

If vandal resistant assemblies are required, the bolt shall have a domed round head with a one-way slot for tightening, and the nuts shall be cone shaped with a hex shaped drive head designed to shear off at a predetermined torque of no less than 4-ft-lbs and no greater than eight 8-ft-lbs when sampled in accordance with Materials Procedure 661.20.00.

661.2.5-Aluminum Structural Shapes: Aluminum structural shapes shown on various sign and delineator Standard Detail sheets, including but not limited to auxiliary angles as shown on Standard Detail sheet TE8-1, zee bar supports as shown on sheet TE6-3D, and extruded rib sign bracing as shown on sheet TE17-1 shall meet ASTM B221, alloy 6061-T6 or 6063-T6.

661.2.6-Banding and Components: Banding and associated components, as specified on Standard Detail sheet TE9-1 or elsewhere, shall meet the requirements specified herein. Banding shall be 3/4-inch width with a minimum thickness of 0.030-inch. Banding shall be manufactured of stainless steel meeting the requirements of ASTM A666, Alloy 201 with a minimum tensile strength of 100,000-PSI.

Flared leg brackets shall be manufactured of stainless steel and shall include a stainless steel bolt, nylon washer, and 5/16-18 x 3/4” stainless steel hex head bolt with metal and fibre washer. Buckles shall be manufactured of stainless steel meeting the requirements of ASTM A666, Alloy 201.

661.2.7-Gaskets: Gaskets, as specified on Standard Detail sheet TE9-1 or elsewhere, shall be manufactured of material meeting the requirements of specification MIL-C-882, cotton duck fabric reinforced pad. Thickness shall be 1/16-inch minimum.

661.2.8-Reflective Sign Support Strips: Materials used to fabricate Reflective Sign Support Strips, as detailed on Standard Detail sheet TE12-1, shall meet the requirements specified herein. Retroreflective sheeting shall be Type ASTM-XI for fluorescent-yellow or fluorescent-yellow-green colored strips. Otherwise, the sheeting shall be Type ASTM-IV.

Reflective Sign Support Strips shall conform to the requirements of 715.9.4.

661.2.9-Post Clip and Extruded Panel Stitch Bolt Assemblies: Post clip and extruded panel stitch bolt assemblies, as detailed on Standard Detail sheet TE7-1, shall meet the requirements specified herein.

Clip shall meet ASTM B108, Alloy 356-T6, aluminum base alloy permanent mold castings. Bolts shall meet ASTM F593, Alloy Group 1, Condition CW. Washers shall meet ASTM F594, Alloy Group 1, Condition CW. Lock Nuts shall be nylon top insert type manufactured of the same stainless-steel alloy group, as defined by ASTM F593, as the bolts and washers, and otherwise shall be manufactured fully in accordance with IFI-100/107.
Dimensioning of components, heads, threads, and marking of the clip shall meet sheet TE7-1. Nuts and washers shall have a specified minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the bolts.

**661.2.10 Rivets:** Rivets to be used for attaching demountable copy, border, and shields to extruded panel signs shall be blind, dome head, self-plugging or pull through type mandrel rivets made of an aluminum alloy that will not produce streaking or discoloring of the sign face. The manufacturer of the rivets shall determine the method of rivet application.

Rivets to be used for attachment of Reflective Sign Support Strips as shown on Standard Detail TE12-1 shall be button head stainless steel blind rivets meeting the requirements of ASME B18.1.1.

**661.2.11 Square Post Clamp Assemblies:** Square post clamp assemblies, as shown on Standard Detail sheets TE16-1A, TE16-1B, and TE17-1 or elsewhere shall meet the requirements specified herein.

The clamp shall be manufactured from 7/8-inch wide, Type 304, #2B finish stainless steel. The assembly shall include a 3/8-inch stainless steel carriage bolt and serrated flange nut supplied as part of the clamp.

**661.2.12 U-Bolts:** U-bolts, as shown on Standard Detail sheet TE9-1 or elsewhere, shall be galvanized carbon steel when attaching to a steel support. Bolts shall meet ASTM A307 Grade A. Nuts shall meet ASTM A563A. Washers shall meet ASTM F844. All components shall be galvanized in accordance to ASTM F2329.

If attaching to an aluminum support, the u-bolts shall be stainless steel. Bolts shall meet ASTM F593 Condition CW2. Nuts shall meet ASTM F594 Condition CW2. Flat washers shall be industry standard. All components shall be alloy 316.

**661.2.13 XS-2 Offset Bracket:** The XS-2 offset bracket detailed on Standard Detail TP5-2 shall be fabricated using steel plate meeting the requirements of ASTM A36 and shall be galvanized in accordance with ASTM A123.

**661.2.14 Sign Supports:** Sign supports shown on various sign and delineator Standard Detail sheets, including u-channel, square tube, and steel beam type sign supports shall meet the requirements of Section 657.

**661.2.15 Delineators:** Materials used to fabricate XS-1 delineators, as detailed on Standard Detail TE11-2B, shall meet the requirements specified herein. Retroreflective sheeting shall be Type ASTM-XI. Fluorescent-yellow shall be used when yellow is specified.

Material requirements for Surface Mounted Flexible Tubular Markers, Soil Anchored Flexible Delineator Posts, Guardrail Mounted Delineator Posts, and Type B-1 Delineators as shown on Standard Detail sheets TE11-2A and TE11-2B shall conform to 715.9.3.

**CONSTRUCTION METHODS**

**661.3 FABRICATION:**
661.3.1-General: Fabrication of all parts shall be in accordance with the dimensions shown on the Plans and approved shop drawings. Work shall be done in a uniform workmanlike manner.

661.3.2- Shop Drawings: The Contractor shall submit to the Engineer for approval eight (8) sets of shop drawings for the items specified below. For the purposes of this section, standard message signs shall be considered to be flat sheet signs shown in the Fabrication Manual.

661.3.2.1- Extruded Panel, Non-Standard Message Signs, Standard Message Signs, Reflective Sign Support Strips, Delineators: Drawings shall show overall dimensioning including corner radiuses. Drawings shall indicate the color and WVDOH type sheetings, inks, and overlay films; the manufacturer and manufacturer’s product number for the sheetings, inks, and overlay films; quantities to be supplied; material specifications for aluminum components; substrate thickness; cross sectional dimensions and lengths for extruded panels and shaped components such as reinforcing ribbing; reinforcing ribbing attachment details; punching details; and hardware to be supplied including material specifications.

Drawings for non-standard message signs shall also show the arrangement, spacing, font style, and size of all letters, symbols, shields, and borders. This shall include all extruded panel signs.

661.3.3-Metal Cutting and Preparation

661.3.3.1-Cutting: Flat sheet aluminum shall be cut by one of the following methods: sheared, blanked, sawed or milled. Extruded Panels shall be sawed or milled. Re-entrant cuts shall be filleted by drilling prior to cutting. No flame cutting will be permitted. Cut edges shall be refinished to present a true and smooth edge that is free from burrs and ragged breaks. Holes shall be made in such a manner as not to affect the finished surface.

661.3.3.2-Preparation: All cutting, cornering, and punching of aluminum blanks shall be completed prior to final preparation for sheeting application. Before applying retroreflective sheeting, the surface of the material must be totally free of any contamination, dust, residue, loose scale and, in particular, traces of oil, grease or wax. Aluminum blanks should be handled by the edges using clean cotton or canvas gloves. In case of doubt as to cleanliness of the substrate, the substrate shall be tested by methods recommended by the sheeting manufacturer.

Immediately prior to the application of the sheeting, if it is necessary to remove any fingerprints or residue from the blanks, solvent wiping in accordance with the sheeting manufacturer’s recommendations shall be used.

661.3.4-Fabrication of Signs, Reflective Sign Support Strips, and Delineators:

661.3.4.1-General: Fabrication of all parts shall be in accordance with the dimensions shown on the Plans and approved shop drawings. Work shall be done in a uniform workmanlike manner.

Any material permanently adhered over the sign background layer of sheeting, such as another layer of sheeting, ink, or film, shall be a “matched component”, as defined in
715.9.2, of the background layer of sheeting. Sheet used on demountable legend, border, and shields riveted to extruded panel signs shall not be required to be a matched component of the extruded panel sign background sheeting. However, the material used for all demountable components on each sign shall be the same series number of sheeting from a single manufacturer. All materials used shall be materials approved by the Division.

All legend, borders, and shields applied to extruded panel signs shall be demountable. All flat sheet signs shall be fabricated using inks and/or overlay films. Direct applied reflective legend and border shall not be allowed. Standard message signs displayed within a sign, such as with W3-1 and W3-2 signs as shown in the Fabrication Manual, may be direct applied.

The fabricator shall take due care to ensure that all sign backgrounds remain clean prior to application of inks and films, solvent wiping the sheeting in accordance with the manufacturer recommendations if necessary.

Materials for fabricating signs shall be stored and conditioned in accordance with the sheeting manufacturer recommendations prior to application. Environmental conditions under which the signs are fabricated shall be in accordance with the sheeting manufacturer recommendations.

661.3.4.1.1-Flat Sheet Fabrication General Requirements: Flat sheet signs, reflective sign support strips, and delineators shall be fabricated of a single piece of sheet material without joints. The height and width of the blank shall be within plus or minus 1/8-inch tolerance of the approved shop drawing dimensions. Corner radii shall be within plus or minus 1/16-inch tolerance of the dimensions shown on the approved shop drawings. Thickness of flat sheet material shall be in accordance with the requirements stated herein.

Blanks shall have dimensions, corner radii, and hole punching in accordance with Standard Detail sheets TP1-1A through TP1-2B, or as otherwise shown in the Plans. All flat sheet signs shall be punched for reinforcing ribbing attachment, with the exception of signs to be attached to a single u-channel or square tube support and Type 1 pole mounts as shown on Standard Detail TE9-1, unless the Standard Details or Plans specify otherwise for a specific assembly or specific assembly type such as the single support GS-1C route marker arrangement shown on Standard Detail TP4-1B.

661.3.4.1.2-Extruded Panel Fabrication General Requirements: Extruded panel signs shall be fabricated of extruded aluminum channel sections, bolted together at the flanges, to form a surface of the length, width, and depth required, to which the legend, border, and background have been applied. The width of the sign shall be within plus or minus 1/4-inch tolerance of the approved shop drawing dimensions. No splicing of sections will be permitted. Unless the required height of the sign is a specified number of feet plus an additional 6-inches, all panels shall be 12-inches in height. Only the minimum number of required 6-inch height panels shall be used. If a 6-inch panel is required, it shall be placed at the top of the sign.

The panels shall be assembled in the shop and firmly bolted to form a sign of the length and width required. Additional stitch bolt holes shall be punched or drilled in the shop when required per Standard Detail TE8-1. Before bolting, the webs of the panels shall be in the same plane to form a smooth and uniform surface and the ends shall be free from projections. Adjacent panels shall be color matched both day and night.
It is intended that the signs shall be fabricated as single units. If the largest signs cannot be shipped as a single unit, they may be sectionalized after being fully assembled in the shop. Legend, shields, and borders which overlap the joints where the signs are sectionalized shall be removed and reinstalled in the field.

661.3.4.2-Application of Retroreflective Sheeting: The application of retroreflective sheeting to the aluminum shall be done mechanically and in full accordance with the instructions of the manufacturer of the sheeting. When manufacturing components such as demountable copy, demountable border, and reflective sign support strips, the fabricator may apply reflective sheeting to a large blank and then cut such components from the sheeting covered blank as permitted by and in accordance with the recommendations of the sheeting manufacturer.

Sheeting shall cover one entire side of each flat sheet blank, which side shall be the sign face. When applied to extruded sign panels, reflective sheeting shall be rolled over each edge of the extrusion 3/8-inch to prevent an opened surface on the sign face. The fabricator shall take due care and follow all manufacturer recommendations in order to ensure that the portion of sheeting rolled over the edges of extruded panels does not fracture at the edge of the panel face and will remain permanently adhered. Manufacturer recommendations typically require the use of heat in addition to edge rollers to provide pressure. On 6-inch wide extruded panels, the fabricator may roll the reflective sheeting over one edge only, provided the trimmed edge is completely adhered and sealed. In addition, the untrimmed edges of 6-inch panels shall face downward upon final fabrication of the sign.

Signs 48-inches and less on the shorter side shall be covered by a single piece of reflective sheeting. On signs larger than 48-inches on the shorter side, horizontal splicing shall be allowed. In this case, the section of sheeting on top shall overlap the bottom section. Adjacent pieces shall be carefully matched for color to provide uniform reflective quality. All seams shall be straight, and the edges of adjustment pieces shall be overlapped a minimum of 3/16-inch the length of the seam.

When manufacturing signs, demountable components, and other products described herein using sheeting material that is “rotationally sensitive”, as defined in 715.9.2, the manufacturing process shall result in the sheeting being oriented optimally, as specified by the sheeting manufacturer, to retroreflect the light from vehicle headlights upon final field installation.

661.3.4.3-Application of Demountable Copy: Each letter, symbol and border shall be secured to the sign surface with rivets meeting the requirements of 661.2.10. The use of tape, glue or other substance to secure the copy to the sign face during fabrication or in its final form shall not be allowed.

Demountable copy, border, and shields shall be attached flush against sign faces after background material has been applied. Spacing and placement of all demountable components shall be as specified on the approved shop drawings. A sufficient number of rivets shall be used to securely fasten demountable components to sign panels.

661.3.4.4-Application of Overlay Films: Signs manufactured using opaque or transparent overlay films shall be manufactured by applying the films in accordance with
all sheeting manufacturer recommendations. All films shall be cut on computer sign cutting equipment incorporating a knife cutting (blade) system.

For signs utilizing transparent overlay film for the background and being greater than 48-inches on the shorter side, splicing of sections of film shall be allowed if required. Each of the sections of film shall be carefully matched for color to provide uniform reflective quality. The method of splicing shall be a butt splice and no overlap shall be allowed for transparent films.

**661.3.4.5-Screen Processing:** All screening shall be done in a workmanlike manner and as recommended by the manufacturer of the reflective sheeting. All legends, symbols, shields, and borders shall be of the color specified and screened on the sign as shown on the Plans. Finished colors after screening shall be in accordance with the color requirements specified in the MUTCD.

The fabricator shall adhere to all sheeting manufacture screening recommendations pertaining to, but not limited to, ink thinning; printing equipment including fabric, stencil, and squeegee; and screening method. Finished signs shall have a uniform color and tone, with sharply defined edges of legend and border and without blemishes on the sign background. Free hand painting will not be permitted.

**661.3.4.6-Packaging:** All signs shall be protected by packaging during shipment and storage. The packing shall be adequate to prevent moisture, abrasive, or excessive pressure damage to any part of the sign, including any demountable legends or borders.

Before packaging, all signs shall be free of moisture and all inks shall be thoroughly dry. All screen-printed signs shall be allowed to dry for a minimum of 24-hours inside of the fabrication facility before packaging. Plastic wrapping which may trap moisture shall not be used. Signs shall be packaged face-to-face and back-to-back placing slip sheeting (silicone side of liner) against each sign face and a non-permeable separator (such as a piece of plastic) shall be placed between signs.

Finished signs shall be shipped on edge and shall not be stacked. Packaging methods which will result in heavy pressure on the face of the signs shall not be used. All packaged signs shall be kept entirely dry until installation. If the sign packaging becomes wet at any time prior to installation, remove the signs, thoroughly dry off and repackage with dry materials. Adhesive tapes shall not be applied to any sign surfaces. Signs shall be adequately protected and supported to avoid scuffing.

Signs delivered for use on the Project shall be stored off the ground. The signs shall be stored in a manner meeting the recommendations of the fabricator and the approval of the Engineer which will prevent moisture on the sign faces and excessive ambient temperatures.

**661.4-ERECCTION:**

**661.4.1-General:** All signs and delineators shall be installed at the points designated on the Plans or by the Engineer in accordance with these specifications, the Plans, and approved shop drawings and shall be erected in reasonably close conformity to the locations, elevations, and angles shown on the Plans or established by the Engineer.
Sign assembly placement requirements are specified in Section 657. All delineators shall be installed at the points designated on the Plans or in the Standard Details unless otherwise directed by the Engineer.

After installation of the signs, they shall be inspected at night by the Engineer. If specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor at his expense to correct this condition.

661.4.2-Signs: Signs shall be attached in accordance with the applicable Standard Detail drawings using hardware meeting the specifications herein or details and hardware specified in the Plans. All signs shall be level after installation. Any appreciable buckling, warping, or other defects in the sign panels due to improper installation shall be cause for rejection of the entire sign.

Signs to be mounted to round poles shall be installed in accordance with Standard Detail TE9-1. All banding for Type 1 pole mount installations shall be double wrapped.

Sign designated in the Plans to be reused shall be carefully removed and stored to prevent damage and shall be reinstalled in accordance with the Standard Details or as specified in the Plans.

661.4.3-Reflective Sign Support Strips: Reflective Sign Support Strips shall be located and installed on assemblies called for in the Plans. Strips shall be installed as shown on Standard Detail TE12-1. Strips shall be installed in accordance with the strip manufacturer’s recommendations.

When installing Reflective Sign Support Strips having a flat cross-sectional shape on the flange side of u-channel supports, the Contractor shall take care in order to not over tighten the hardware causing deformation of the face of the strip.

661.4.4-Delineators:

661.4.4.1-Location: Delineators shall be spaced and placed in accordance with Standard Details TE11-1 through TE11-3C unless otherwise specified in the Plans.

Color of delineators shall be in accordance with the Standard Details. Delineator color shall match the color of the pavement marking that the delineator is intended to supplement, with the exception of red sheeting intended to warn wrong direction traffic.

Where an obstruction intrudes into the space between the pavement edge and the extension of the line of the delineators, the delineators should be transitioned to be in line with or inside the innermost edge of the obstruction. When uniform spacing is interrupted by such features as driveways and intersections, delineators which would ordinarily be located within the features may be relocated in either direction for a distance not exceeding one quarter of the uniform spacing. Delineators still falling within such features may be eliminated.

661.4.4.2-Installation: Surface Mounted Flexible Tubular Markers, Soil Anchored Flexible Delineator Posts, Guardrail Mounted Delineator Posts, and Type B-1 Delineators shall be installed in accordance with the manufacturer’s recommendations. All Surface Mounted Tubular Markers and permanent B-1 Delineators shall be fastened to the surface using the recommended hardware supplied by the manufacturer.
XS-1 delineators shall be installed in accordance with the provided details. XS-1 delineators installed on bridges with a bicycle railing shall be installed in accordance with Standard Detail TE11-2B.

661.4.5-Final Clean Up: Before final inspection, the Contractor shall perform any touching up on paint finishes, cleaning of exposed sign and support surfaces, and leveling and repair of the site as may be deemed necessary by the Engineer to insure the effectiveness and neat appearance of the work.

661.5-METHOD OF MEASUREMENT:

661.5.1-Signs: Measurement for payment for all types of signs will be based on the area in square feet of the sign faces. Areas shall be calculated to the nearest 0.01 square foot for each sign and to the nearest square foot for the total quantity. The area of any sign shall be the area of the smallest rectangular, triangular or trapezoidal shape that will encompass the entire sign; except for extruded panel signs, which shall have an area equal to the smallest combination of rectangular, triangular, or trapezoidal shapes that constitute the sign.

661.5.2-Reflective Sign Support Strips: Measurement for payment for Reflective Sign Support Strips will be based on the actual number of strips necessary to complete the work. The presence of a strip or combination of strips on any one face of a support shall constitute one unit.

661.5.3-Delineators: Measurement for payment for Surface Mounted Flexible Tubular Markers, Soil Anchored Flexible Delineator Posts, Guardrail Mounted Delineator Posts, Type B-1 Delineators, and XS-1 Delineators will be based on the actual number of such devices necessary to complete the work.

661.5.4-XS-2 Offset Bracket: Payment for any required XS-2 Offset Brackets shall be paid for incidental to the Contract bid items. Payment shall include hardware necessary to install the bracket.

661.5.5-Installation of Reusable Signs: Measurement for payment for installation of reusable signs will be based on the actual number of signs the Contractor is required to remove and reinstall.

661.6-BASIS OF PAYMENT:

The quantities, determined as provided above, shall be paid for at the contract unit price for the items listed below, which prices and payments shall be full compensation for furnishing all the materials and doing all work prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, supplies, and incidentals necessary to complete the work.

All incidental work and materials for which no basis of payment is provided will be considered as completely covered by the prices bid for the items included in the Contract.

661.6.1-Signs: Payment will be made at the contract unit price per square foot of sign for the appropriate type of sign. This price shall be full compensation for fabricating, furnishing, and attaching the sign or sign assembly to the post or posts as shown on the Plans or specified.
It shall include the furnishing of the aluminum sign panels; all framing, bracing, attachment, and connections necessary to attach the signs to the supports; furnishing and applying the reflective sheeting, or other sign facing material; furnishing and applying the demountable copy or the process material and screens for screening the legend and border to the sign face as required by the Plans; and furnishing all hardware required for the above. This item does not include posts.

661.6.2-Reflective Sign Support Strips: Payment will be made at the contract unit price per each Reflective Sign Support Strip. This price shall be full compensation for fabricating, furnishing, and attaching the strip to the support as shown on Standard Detail TE12-1 or as recommended by the manufacturer. It shall include the furnishing of the strips and all hardware necessary to attach the strip to the support.

661.6.3-Delineators: Payment will be made at the contract unit price per installation for Surface Mounted Flexible Tubular Markers, Soil Anchored Flexible Delineator Posts, Guardrail Mounted Delineator Posts, Type B-1 Delineators, and XS-1 Delineators. Payment shall include all materials, including u-channel supports, anchors, and hardware necessary to install the delineators. The same unit price shall be paid for delineators of the same type having sheeting on one or both faces.

661.6.4-Installation of Reusable Signs: Payment will be made at the contract unit price per installation of reusable sign. This price shall be full compensation for transporting the sign to the nearest possible location shown on the Plans and erection of the sign, including furnishing the necessary hardware and all other material, labor, equipment and tools necessary to complete the installation.

661.7-PAY ITEMS:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>661001-#</td>
<td>0.080 Flat Sheet Sign</td>
<td>Square Foot</td>
</tr>
<tr>
<td>661002-#</td>
<td>Extruded Panel Sign</td>
<td>Square Foot</td>
</tr>
<tr>
<td>661003-#</td>
<td>Reflective Sign Support Strip</td>
<td>Each</td>
</tr>
<tr>
<td>661011-#</td>
<td>Installation of Reusable Sign</td>
<td>Each</td>
</tr>
<tr>
<td>661014-#</td>
<td>Surface Mounted Flexible Tubular Marker</td>
<td>Each</td>
</tr>
<tr>
<td>661015-#</td>
<td>Soil Anchored Flexible Delineator Post</td>
<td>Each</td>
</tr>
<tr>
<td>661016-#</td>
<td>Guardrail Mounted Delineator Post</td>
<td>Each</td>
</tr>
<tr>
<td>661017-#</td>
<td>XS-1 Delineator</td>
<td>Each</td>
</tr>
<tr>
<td>661020-#</td>
<td>Delineator, Type B-1</td>
<td>Each</td>
</tr>
</tbody>
</table>

* Sequence Number
715.9-WARNING DEVICES:

715.9.3-Channelizing Devices and Auxiliary Barriers:

DELETE ENTIRE SUBSECTION 715.9.3 AND REPLACE WITH THE FOLLOWING:

715.9.3-Channelizing Devices: Channelizing Devices shall include Drums, Channelizer Cones, Cones, Barricades, Surface Mounted Flexible Tubular Markers, Soil Anchored Flexible Delineator Posts, Guardrail Mounted Delineator Posts, and Type B-1 Delineators. Requirements in order to be listed on the Division APL are contained within this section for applicable devices.

Devices which are included as part of the AASHTO National Transportation Product Evaluation Program (AASHTO-NTPEP), and for which an APL is maintained, shall be tested as part of the AASHTO-NTPEP in order to be considered for approval.

With the exception of Guardrail Mounted Delineator Posts and Type B-1 Delineators, all devices described above shall be crashworthy when assembled, installed, and utilized in accordance with the device manufacturer’s instructions. Crashworthy shall be defined as meeting the crash testing performance requirements of National Cooperative Highway Research Program Report 350 (NCHRP-350) Test Levels I, II, and III for projects let on or prior to December 31, 2019, and shall be defined as meeting the crash testing performance requirements of the 2016 edition AASHTO Manual for Assessing Safety Hardware (MASH-2016) at Test Levels I, II, and III for projects let after December 31, 2019. Devices which meet MASH-2016 and that have not been tested to NCHRP-350 may be used on projects with a letting date on or prior to December 31, 2019. Devices used for temporary traffic control applications that are manufactured on or prior to December 31, 2019 which meet NCHRP-350, but do not meet MASH-2016, may be used on projects with a letting date on or prior to December 31, 2022.

Device manufacturer instructions shall be within the scope of the successful crash testing. Scope shall include parameters such as size, weight, placement, and material makeup of potential device attachments; location, weight, and material makeup of additional device ballast; etc. Manufacturer instructions regarding such parameters may be outside the scope of testing only if allowed for in the FHWA eligibility letter or by written guidance or policy issued by the FHWA or AASHTO.
The manufacturer shall be required to demonstrate the crashworthiness of a device as part of the submittal requesting consideration for including the device on the Division APL. Demonstration shall be by means of the manufacturer’s NCHRP-350 or MASH-2016 self-certification letter for Drums, Channelizer Cones, Surface Mounted Flexible Tubular Markers, and Soil Anchored Flexible Delineator Posts. Barricades eligible for use based on meeting NCHRP-350 shall be demonstrable to meet NCHRP-350 by means of a FHWA eligibility letter and are not required to be listed on the APL. Barricades required to meet MASH-2016 are required to be listed on the APL and shall be demonstrable to meet MASH-2016 by means specified in official guidance issued by the WVDOH.

The Contractor shall be required to demonstrate the crashworthiness of Cones to be utilized upon the Engineer’s request. Demonstration shall be by means of the manufacturer’s self-certification letter referencing the applicable crash testing standard.

References within this section to the “Traffic Control Manual” shall be interpreted as referencing the WVDOH Manual on Temporary Traffic Control for Streets and Highways Traffic Control Manual, latest edition.

### 715.9.3.1-Drums:

Drums shall be designed, tested, and supplied in accordance with the following requirements:

1. Material shall be lightweight, typically plastic such as polyethylene, designed to yield and separate from the base upon impact, and to be returned to its original shape if deformed. Metal or otherwise rigid drums shall not be approved. Material shall be colored bright orange and shall be resistant to deterioration and fading from UV light exposure.
2. Device shall appear cylindrical from any direction and shall have a closed top.
3. Device height and width shall be in accordance with the requirements shown in the Traffic Control Manual.
4. Device shall be equipped with retroreflective sheeting placed as required by the Traffic Control Manual. Retroreflective sheeting shall be Type ASTM-IV material noted for use on Drums on the WVDOH APL for retroreflective sheeting.
5. Device base design shall be solid rubber or sand filled plastic. Ring type bases shall not be approved.
6. Device drum and base shall incorporate anti-roll mechanisms to prevent continuous rolling if knocked over.

### 715.9.3.2-Channelizer Cones:

Channelizer Cones shall be designed, tested, and supplied in accordance with the following requirements:

1. Material shall be lightweight, typically plastic such as polyethylene, designed to yield and separate from the base upon impact, and to be returned to its original shape if deformed. Metal or otherwise rigid Channelizer Cones shall not be approved. Material shall be colored bright orange and shall be resistant to deterioration and fading from UV light exposure.
2. Device shall appear cylindrical from any direction and shall have a closed top.
3. Device diameter at the top edge of the top band of sheeting shall be approximately 4-inches. Device diameter at the bottom edge of the bottom band of sheeting shall be approximately 5-1/2 inches. The device may be constructed
such that the diameter transitions from the top to the bottom uniformly or tiered such that the section of the device that each band of sheeting is attached to is of a different constant diameter.

iv. Device retroreflective markings shall be horizontal, circumferential, alternating orange and white retroreflective stripes 6-inches wide. A minimum of two orange and two white stripes shall be used with the top stripe being orange. The top edge of the top band shall be approximately 43-inches above ground level and non-retroreflectorized gaps between the orange and white stripes shall not exceed 1-inch.

v. Retroreflective sheeting shall be Type ASTM-IV material noted for use on Channelizer Cones on the WVDOH APL for retroreflective sheeting.

vi. Two different subcategories of Channelizer Cones are recognized: Devices for use on roadways with a normal posted speed limit of 55 MPH or less, and devices for use on all roadways. The device shall be approved under one or both subcategories based on the acceptable bases available. Base requirements for use on roadways 55 MPH or less are as follows:
   a. Base shall be drop-on type manufactured of solid rubber and shall not be round.
   b. Minimum weight of 15 lbs.
   c. The square or rectangular footprint defined by the outer extremes of the base shall not exceed 20-inches x 20-inches if square and shall not exceed 18-inches in one direction or 24-inches in the other if rectangular.

vii. Base requirements for use on all roadways are as follows:
   a. Base shall be drop-on type manufactured of solid rubber and shall be rectangular.
   b. Minimum weight of 20 lbs.
   c. The dimension of the base on the short side shall be a minimum of 12-inches and a maximum of 20-inches. The dimension of the base on the long side shall be a minimum of 24-inches.

715.9.3.3-Cones: Cones shall be designed, tested, and supplied in accordance with the following requirements:

   i. Material shall be lightweight, typically polyvinyl chloride, designed to yield upon impact and returned to its’ original shape if deformed. Metal or otherwise rigid cones shall not be allowed. Material shall be colored fluorescent orange and shall be resistant to deterioration and fading from UV light exposure.
   ii. Device height and overall general shape shall be in accordance with the Traffic Control Manual.
   iii. Device shall be equipped with retroreflective sheeting as required by the Traffic Control Manual. Sheet ing placement shall be in accordance with the requirements of the Traffic Control Manual. Retroreflective sheeting shall be Type ASTM-IV material noted for use on Cones on the WVDOH APL for retroreflective sheeting.
   iv. Device shall be adequately designed to resist displacement and tipping from wind and vibrations, as well as slumping due to heat.
715.9.3.4-Barricades: Type I, II, and III Barricades shall be designed, tested, and supplied in accordance with the following requirements:

i. Barricade rail material shall be a lightweight, typically polymer material such as polyethylene, polyurethane, or engineered thermoplastic. Other materials such as aluminum or wood shall not be approved. Support frame components shall be manufactured of materials similar to those described above or may be metal. Wood shall not be approved.

ii. Minimum Barricade height, rail length, and individual rail height shall be in accordance with the requirements of the Traffic Control Manual.

iii. Device rails shall be white.

iv. Device shall be equipped with retroreflective sheeting designed and placed as required by the Traffic Control Manual. Retroreflective sheeting shall be Type ASTM-IV material noted for use on Barricades on the WVDOH APL for retroreflective sheeting.

v. Type III Barricades shall incorporate horizontal skids for stability.

715.9.3.5-Surface Mounted Flexible Tubular Markers: Surface Mounted Flexible Tubular Markers (SMFTM’s) shall be designed, tested, and supplied in accordance with the following requirements:

i. Material shall be a lightweight, typically polymer material such as polyethylene, polyurethane, or engineered thermoplastic, and shall be designed to yield upon impact and to be returned to its’ original position and, if designed to be deformable, shape when impacted from any direction. Except for components as allowed for herein, SMFTM’s shall not be manufactured of metal. SMFTM’s manufactured of rigid material shall not be approved without a mechanism, such as a spring, included as part of the device design which allows the entire tube above the base to yield when impacted. Material shall be resistant to impact as well as deterioration and fading from UV light exposure. Device shall be available with white, yellow, and orange tubes.

ii. No metal or otherwise rigid components shall become projectiles upon impact.

iii. Tubes shall provide 360-degree visibility for their entire length with a minimum profile of 2-inches. Cross-sectional shape at the reflective portion shall be uniform.

iv. Device shall be manufactured such that the top of the SMFTM is 36-inches above the bottom of the base after installation.

v. For white and yellow tubes, device shall include a white or yellow 6-inch wide band of retroreflective sheeting matching the SMFTM tube color, preinstalled by the manufacturer. The band shall be wrapped completely around the tube, with the bottom edge of the sheeting no less than 28-inches above the bottom of the base. For temporary orange applications, device shall include retroreflective sheeting sized and placed in accordance with the Traffic Control Manual.

vi. Retroreflective sheeting shall be Type ASTM-IV material noted for use on SMFTM’s on the WVDOH APL for retroreflective sheeting.
vii. Hardware shall be supplied by the manufacturer and shall be manufactured using stainless, zinc plated, or galvanized steel; aluminum; or similar material exhibiting weather resistance equal to or greater than those described.

viii. Bases shall be colored black. In order to be approved for permanent applications, the bases shall be designed to allow mechanical fastening to the roadway using asphalt or concrete anchors. Appropriate anchors for the intended substrate shall be supplied by the manufacturer for permanent applications. SMFTM’s whose bases are recommended by the manufacturer for installation using only non-mechanical means such as mixed, melted, or preformed adhesive shall be considered for temporary use approval only.

715.9.3.6-Soil Anchored Flexible Delineator Posts: Soil Anchored Flexible Delineator Posts (SAFDP’s) shall be designed, tested, and supplied in accordance with the following requirements:

i. Material shall be a lightweight, typically polymer material such as polyethylene, polyurethane, or engineered thermoplastic, and shall be designed to yield upon impact and to be returned to its’ original position and, if designed to be deformable, shape when impacted from any direction. Except for components as allowed for herein, SAFDP’s shall not be manufactured of metal. SAFDP’s manufactured of rigid material shall not be approved without a mechanism, such as a spring, included as part of the device design which allows the entire portion of the post above the base to yield when impacted. Material shall be resistant to impact as well as deterioration and fading from UV light exposure. Posts shall be available in white and yellow.

ii. No metal or otherwise rigid components shall become projectiles upon impact.

iii. Device shall be manufactured such that the top of the delineator is 54-inches above the ground surface after installation.

iv. Post cross sectional shape may be flat, convex, or round. Post shall be of a uniform cross-sectional shape at the reflective portion with a flat or convex shaped front face.

v. Retroreflective sheeting shall be a Type ASTM-XI material on the WVDOH APL for retroreflective sheeting. Yellow sheeting shall be fluorescent.

vi. Device shall include one 3-inch wide by 9-inch tall strip of retroreflective sheeting on the front face matching the SAFDP color. If required by the Plans, device shall accommodate and include one 3-inch wide by 9-inch tall strip of fluorescent-yellow or red retroreflective sheeting on the back face. The top edge of the sheeting shall be 2-inches or less from the top of the post. All sheeting shall be preinstalled by the manufacturer.

vii. Device anchor shall be galvanized steel designed for 18-inch minimum embedment.

viii. Hardware shall be supplied by the manufacturer and shall be manufactured using stainless, zinc plated, or galvanized steel; aluminum; or similar material exhibiting weather resistance equal to or greater than those described.
715.9.3.7- Guardrail Mounted Delineator Posts: Guardrail Mounted Delineator Posts (GMDP’s) shall be designed, tested, and supplied in accordance with the following requirements:

i. Material shall be a lightweight, typically polymer material such as polyethylene, polyurethane, or engineered thermoplastic. Device shall be designed to yield upon impact and to return to its’ original position and shape when impacted from the front or back. Except for components as allowed for herein, GMDP’s shall not be manufactured of metal. GDMP’s manufactured of rigid material shall not be approved without a mechanism, such as a spring, included as part of the device design which allows the entire portion of the device above the top of the guardrail to yield when impacted. Material shall be resistant to impact as well as deterioration and fading from UV light exposure. Posts shall be available in white and yellow.

ii. No metal components shall become projectiles upon impact.

iii. Device shall be manufactured such that the top of the post sheeting is 20-inches minimum above the top of the guardrail after installation.

iv. Cross sectional shape may be flat, convex, or round. Post shall be of a uniform cross-sectional shape at the reflective portion with a flat or convex shaped front face.

v. Designs which are entirely made up of a single flat or convex shaped piece of material shall allow for installation as shown on Sheet TE11-2A of the West Virginia Department of Transportation, Division of Highways, Standard Details Book Vol. II, Signing, Signals, Lighting, and Marking.

vi. Retroreflective sheeting shall be a Type ASTM-XI material on the WVDOH APL for retroreflective sheeting. Yellow sheeting shall be fluorescent.

vii. Device shall include one 3-inch wide by 9-inch tall strip of retroreflective sheeting on the front face matching the GMDP color. If required by the Plans, the device shall accommodate and include one 3-inch wide by 9-inch tall strip of fluorescent-yellow or red retroreflective sheeting on the back face. All sheeting shall be preinstalled by the manufacturer.

viii. Any required hardware other than that shown on Standard Detail TE11-2A shall be supplied by the manufacturer and shall be manufactured using stainless, zinc plated, or galvanized steel; aluminum; or similar material exhibiting weather resistance equal to or greater than those described.

715.9.3.8-Type B-1 Delineators: Type B-1 Delineators shall be designed, tested, and supplied in accordance with the following requirements:

i. Material shall be a lightweight, typically polymer material such as polyethylene, polyurethane, or engineered thermoplastic. Except for components as allowed for herein, Type B-1 Delineators shall not be manufactured of metal. Material shall be resistant to impact as well as deterioration and fading from UV light exposure.

ii. No metal components shall become projectiles upon impact.

iii. The front and back faces of the device substrate to which the reflective sheeting is to be applied shall be white or yellow to match the color of the sheeting or shall be a neutral color such as black or grey.
iv. Device may be a one-piece design or two-piece design utilizing a separate bracket with the reflective portion attached to the bracket using one or more fasteners. The bracket portion may be metal but shall not extend more than three-inches above the top of the barrier. In addition, the bracket shall not obscure more than ten-percent of the reflective face.

v. The cross-sectional shape of the reflective portion of the device shall be flat.

vi. Retroreflective sheeting shall be a Type ASTM-XI material on the WVDOH APL for retroreflective sheeting. Yellow sheeting shall be fluorescent.

vii. Front face of device shall accommodate reflective sheeting 8-inches wide by 12-inches tall, in white or fluorescent yellow as specified. If required by the Plans, device shall accommodate and include one 8-inch wide by 12-inch tall strip of fluorescent-yellow or red retroreflective sheeting on the back face. All sheeting shall be preinstalled by the manufacturer.

viii. In order to be approved for permanent applications, the device shall be designed to allow mechanical fastening to the top of a concrete barrier wall as narrow as 6-inches.

ix. All required hardware and other metal components shall be supplied by the manufacturer and shall be manufactured using stainless, zinc plated, or galvanized steel; aluminum; or similar material exhibiting weather resistance equal to or greater than those described. Anchors shall be suitable for use in concrete. If the use of an adhesive material for attachment is allowed for by the manufacturer for temporary applications, the adhesive shall be provided by the manufacturer.

715.9.3.9- **Product Submission and Approval:** Drums, Channelizer Cones, Barricades, Surface Mounted Flexible Tubular Markers, Soil Anchored Flexible Delineator Posts, Guardrail Mounted Delineator Posts, and Type B-1 Delineators to be considered for inclusion on the Division’s APL’s shall be submitted to the Materials Division following the current procedures specified in MP 106.00.02.

The manufacturer should include all relevant documentation and information, including but not limited to product data sheets, product flyers, manufacturer product specifications and recommendations, product bulletins, engineering drawings, AASHTO-NTPEP test results, and crash testing performance documentation.

In addition to the above, field evaluation installations may be required prior to approval. In order for the device to be approved, evaluation installations installed by or for the Division shall demonstrate levels of durability, reliability, performance, and ease of installation/repair determined to be acceptable to Division evaluation personnel. Details related to this testing, such as locations, quantities, and duration shall be determined by the Division. Initial and typical repair material costs associated with the device shall also be considered as part of the evaluation.
715.9.4 BLANK

DELETE SUBSECTION 715.9.4 AND REPLACE WITH THE FOLLOWING:

715.9.4 Proprietary Reflective Sign Support Strips: Approved Proprietary Reflective Sign Support Strips (strips) for use on WVDOH projects are listed on the Materials Division “Reflective U-Channel Strips” Approved Products List (APL).

Strips shall be manufactured using polymer materials such as polyethylene, polyurethane, or engineered thermoplastics, and shall be manufactured to be resistant to impact as well as deterioration and fading from UV light exposure and the elements. The color polymer shall be white, black, or grey. Strips may alternatively be manufactured of aluminum no thicker than 0.080 inches. If manufactured of aluminum, the strips shall include no sharp corners.

The width of reflective sheeting on the face of strips shall be a minimum of four 4-inches. If manufactured of aluminum, the entire face of the strips shall be covered by sheeting. Plastic strips may be manufactured to an overall maximum width equal to the width of sheeting applied to the face of the strips plus 1/2-inch with a maximum of 1/4-inch of the face of the strips extending beyond the edge of the reflective sheeting on each side. All strips shall have reflective sheeting applied completely to the end of the strips on the top and bottom.

Different combinations of different length strips will be allowed in order to meet the 72-inch typical overall length shown on the Standard Detail; however, the shortest standard-length strip allowed shall be 18-inches. The strip system shall be designed to allow adjacent strips to be butted end to end and fastened in place with no gap between the ends of the strips. Different models of strips designed to attach to the web side only, flange side only, or either the web or flange side of u-channel posts shall be allowed with a description of each specific model to be posted on the APL. Completely flat panels shall also be allowed and shall be required for S or W beam post, as well as square tube applications. Strips intended for application to the flange side of u-channel posts shall be designed to resist warping when fastened in place.

The retroreflective sheeting used on strips shall be a material listed on the latest WVDOH APL for retroreflective sheeting. The color sheeting to be applied to the strips will be specified in the Plans. The sheeting shall be Type ASTM-XI if the sheeting is to be colored fluorescent-yellow or fluorescent-yellow-green. Otherwise, the sheeting shall be Type ASTM-IV. Strips shall be supplied with sheeting pre-installed by the manufacturer.

The manufacturer shall supply or provide specifications for all hardware required for installation. All metal hardware shall be manufactured of stainless, zinc plated, or galvanized steel, or shall be manufactured of aluminum.

715.9.4.1 Product Submission and Approval: Strips to be considered for inclusion on the Division APL shall be submitted to the Materials Division following the current procedures specified by the Division in MP 106.00.02. The manufacturer should include all relevant documentation and information, including but not limited to Product Data Sheets, Product Flyers, Manufacturer Product Specifications, Product Bulletins, and Engineering Drawings.

As part of the approval process, the strip manufacturer shall be required to submit a copy of a letter of assurance which addresses reflective sheeting compatibility and application procedures. This letter shall be addressed from the reflective sheeting manufacturer to the strip manufacturer. A separate letter shall be required from each
sheeting manufacturer that the manufacturer anticipates utilizing. The language of the letter shall provide sufficient indication, in the Division’s judgement, that a) the sheeting manufacturer is aware of the intended application and has determined that the reflective sheeting to be utilized is suitable for use with the product, and b) the reflective sheeting manufacturer has reviewed their recommended reflective sheeting application procedures with the manufacturer.

In addition to the above, field evaluation installations may be required prior to approval. In order for the device to be approved, evaluation installations installed by or for the Division shall demonstrate levels of durability, reliability, performance, and ease of installation/repair determined to be acceptable to Division evaluation personnel. The duration of the field evaluations shall typically be a minimum of six months to one year. Specific details related to this testing, such as locations and quantities, shall be determined by the Division. Initial and typical repair material costs associated with the device shall also be considered as part of the evaluation.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 664
TRAFFIC SAFETY DEVICES

664.2-MATERIALS:

DELETE THE CONTENTS OF SUBSECTION 664.2 AND REPLACE WITH THE FOLLOWING:

Materials shall conform to the requirements of the following subsections of Division 700.

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>SUBSECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reusable Energy Absorbing Crash Terminal Device (Type I)</td>
<td>715.41.5</td>
</tr>
<tr>
<td>Trinity Attenuating Crash Cushion (Type II) *</td>
<td>715.41.6</td>
</tr>
<tr>
<td>SCI Impact Attenuating Device (Type III) *</td>
<td>715.41.7</td>
</tr>
<tr>
<td>Sand Barrel Impact Attenuating Device (Type V)</td>
<td>715.41.1</td>
</tr>
<tr>
<td>Crash Cushion Terminal Impact Attenuating Device (Type VI)</td>
<td>715.41.2</td>
</tr>
<tr>
<td>Truck Mounted Attenuating Devices (Type VII)</td>
<td>715.41.3</td>
</tr>
<tr>
<td>Quad Guard Terminal Device (Type VIII) *</td>
<td>715.41.4</td>
</tr>
<tr>
<td>TAU-II Impact Attenuating Device (Type IX) *</td>
<td>715.41.8</td>
</tr>
</tbody>
</table>

* When Item 664001-016, “Impact Attenuating Device” is included as a pay item in the Contact, Type II, Type III, Type VIII, or Type IX device listed on the Division’s Approved Products List (APL) meeting the applicable crash testing standard and specified test level may be utilized.

664.2.1-Design Drawings: With the exception of Type V and VII devices, the Contractor shall submit to Traffic Engineering Division eight (8) sets of design (installation) drawings for the device to be utilized. Drawings shall be site specific providing an accurate representation of the obstacle being shielded, concrete pads and backups to be installed, as well as any required transitions. This drawing will be reviewed and, if approved, it will be stamped and one copy returned to the Contractor. Multiple devices of the same design to be installed under identical conditions may be represented by one (1) set of drawings.
664.3-CONSTRUCTION METHODS:
664.3.1-Impact Attenuating Devices:

DELETE THE SECOND AND THIRD PARAGRAPH IN THE SUBSECTION AND REPLACE WITH THE FOLLOWS:

With the exception of Type VI and VII devices, permanent devices shall be installed on a concrete pad meeting the requirements of the device manufacturer. Other support surfaces meeting the requirements of the device manufacturer such as combinations of concrete, asphalt, and/or subbase layers shall be permissible for temporary devices. The lateral slope of the installation site shall be within the device manufacturer’s tolerances and still provide adequate drainage.

The nose of the device shall have the appropriate version, based on the site-specific traffic configuration, XS-15 marker attached to the nose of the device. The stripes for construction zone attenuating devices shall be as above except the stripes shall be reflectorized white and reflectorized orange.
715.41-TRAFFIC SAFETY DEVICES:

DELETE THE ENTIRE CONTENTS OF SUBSECTION 715.41 AND REPLACE WITH THE FOLLOWING:

All devices described herein shall be crashworthy when assembled, installed, and utilized in accordance with the device manufacturer’s instructions. Crashworthy shall be defined as meeting the crash testing performance requirements of National Cooperative Highway Research Program Report 350 (NCHRP-350) at Test Level II or III, as specified in the Plans or otherwise herein, for projects let on or prior to December 31st 2018, and shall be defined as meeting the crash testing performance requirements of the 2016 edition AASHTO Manual for Assessing Safety Hardware (MASH-2016) at Test Level II or III, as specified in the Plans or otherwise herein, for projects let after December 31st 2018. Devices which meet MASH-2016 and that have not been tested to NCHRP-350 may be used on projects with a letting date on or prior to December 31, 2018. Devices to be used on a temporary basis in work zone applications that are manufactured on or prior to December 31, 2018 which meet NCHRP-350, but do not meet MASH-2016, may be used on projects with a letting date on or prior to December 31, 2021.

Dates specified above shall apply to all devices except Type VII. Type VII devices shall meet NCHRP-350, or MASH-2016, for projects let on or prior to December 31, 2019. Except as otherwise allowed herein, Type VII devices shall meet MASH-2016 for projects let after December 31, 2019. Type VII devices that are manufactured on or prior to December 31, 2019 which meet NCHRP-350, but do not meet MASH-2016, may be used on projects with a letting date on or prior to December 31, 2022.

Devices listed on the Division Approved Products List (APL) for Traffic Safety Devices will include notations which specify the crash testing standards and test levels which the device meets.

715.41.1-Sand Barrel Impact Attenuating Device (Type V):

715.41.1.1-Description: The unit shall have cylindrical containers capable of holding various amounts of sand. The amount of sand capable of being held shall include at least 2, 4, 7, 14, or 21 cubic feet (0.056, 0.112, 0.196, 0.393 or 0.588 cubic meters).
715.41.1.2-Performance: The manufacturer shall certify that the units shall not crack, split, or color fade within five years of installation.

715.41.2-Crash Cushion Terminal Impact Attenuating Device (Type VI): Type VI devices shall be post anchored terminals designed for shielding the ends of double faced guardrail. No concrete or asphalt pad shall be required. The device shall be compatible with double faced w-beam guardrail as shown in the WVDOH Standard Details Book Volume I, with any necessary transitions provided with the device. Transitions, if necessary, shall be available for attachment to 31-inch high guardrail with 6’-3” post spacing with splices mid-span, as well as 28-1/2-inch high guardrail with 6’-3” post spacing with splices on the supports. Supports may be proprietary or non-proprietary steel or wood. Rails may be proprietary or non-proprietary steel standard AASHTO guardrail beams. The device shall incorporate a mechanism of dissipating the kinetic energy of a vehicle impacting the front end of the device such as but not limited to kinking, buckling, shearing, or extruding of the device rails; or frictional resistance. The device shall be fully redirective for side impacts beginning no further than 19-feet downstream of the first support post.

715.41.3-Truck Mounted Impact Attenuating Device (Type VII): The unit shall consist of a crushable cartridge, a backup and a backup support structure for attaching the backup to the shadow vehicle. The unit shall have a standard trailer lighting system, including brake lights, taillights, turn signals and ICC bar lights. The back of the unit shall have a device attached with alternative diagonal black and reflectorized yellow stripes, 6 inches (150 mm) wide, similar to an XS-15 marker and in accordance with Section 3C-2 of the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways.

The manufacturer specifications and user manual shall clearly specify minimum and maximum specified host vehicle weights and shall provide estimated roll-ahead distances based on various host-vehicle weights. The minimum and maximum specified host vehicle weights shall in accordance with recommendations contained within the applicable crash testing standard.

715.41.4-Quad Guard Impact Attenuating Device (Type VIII): The unit shall consist of crushable cartridges surrounded by a framework of steel Quad-beam guardrail which can telescope rearward during head-on impacts. The quad Guard System shall have a center monorail which will resist lateral movement during side angle impacts. The nose shall consist of a formed plastic or metal nose wrap.

715.41.5-Reusable Energy Absorbing Crash Terminal Device (Type I): The unit shall consist of high-density polyethylene cylinders, which will compress and absorb energy. In addition, these cylinders under most circumstances will recover their shape, position, and absorption capabilities sufficiently enough, after being impacted by a vehicle, to withstand another impact by a vehicle. Each cylinder shall be 24” (611 mm) to 36” (908 mm) in outside diameter and 32” (813 mm) to 48” (1220 mm) high. Cylinder color shall be black. Cylinder Units shall have a cover. The unit shall have a restraining cable system of heavy steel galvanized wire rope on each side of the row of cylinders.
715.41.6-Trinity Attenuating Crash Cushion (Type II): The unit shall consist of a pair of guidance tracks, an impact “sled,” intermediate steel frames, and 10 gauge W-Beam fender panels. The overall width should be 24 inches (610 mm). The guidance tracks are made from two C-channels formed into a box section by variable lengths and thicknesses of metal rip plates bolted to the outside flanges of the channels. The sled, or impact face, of the TRACC is positioned over the upstream end of the guidance tracks and contains a hardened steel blade which cuts the metal plates on the sides of the guidance tracks as it is forced backwards in an end hit. The intermediate frames support the W-beam fender panels and are free to slide backwards when the TRACC is hit on the end, but lock onto the guidance tracks to provide redirection for side impacts.

The fender panels are bolted to the intermediate frames with a design that locks the inside panels in place while allowing the outer panels to slide back freely as the system telescopes rearward.

715.41.7-SCI Impact Attenuating Device (Type III): The unit shall consist of a flat galvanized steel base plate, to be attached to the support surface with chemical anchor bolts, with welded galvanized steel reinforcing support gussets and two welded galvanized steel channel beams running the length of the unit.

The internal area of the unit shall be supported laterally by a framework consisting of a welded up galvanized steel box shaped “sled” at the front of the unit, followed by successive welded galvanized steel support diaphragms to which the left and right sides of the unit are to be connected. The sled and diaphragms shall be locked into and held in position laterally by, and shall be capable of sliding longitudinally along, the channel beams included as part of the base.

Each side of the unit shall provide a surface to capture and redirect impacting vehicles by using successive galvanized steel 10 ga. quad beam side panels, overlapped from the rear to the front of the unit, with the beginning of the front side panels attached to the front sled, and the underlying panels at each overlap to be attached to an internal support diaphragm.

The kinetic energy dissipating system employed by the unit for front impacts shall consist of a round, non-rotating, steel sheave assembly at the front of the unit with the ability to slide longitudinally along the unit; two round, non-rotating, steel sheave assemblies at the rear of the unit connected by an energy dissipating hydraulic piston; and a galvanized steel cable interconnecting the sheaves. During front end impacts, the entire device shall telescope rearward. Energy shall be dissipated variably, dependent on the vehicle momentum, by the hydraulic piston as it is compressed by the two rear sheave assemblies as tension is induced in the cable.

For protection of the components, the unit shall be designed such that the tops of the sheave assemblies and piston sit below the top level of the base plate channel beams. In addition, the unit shall be designed such that when fully collapsed, all of the sheave assemblies and piston shall remain behind the front sled.

The total outside to outside width of the unit along its’ entire length shall be approximately 36”. The length of the unit from the front to rear of the support base shall be approximately 21-1/2 feet.

715.41.8- TAU-II Impact Attenuating Device (Type IX): The device shall accommodate a wide range of hazard widths up to 8-1/2 ft (2.6 m) in six (6) inch (150 mm) increments. The
device shall be available in various impact speed capacities, achievable by different combinations of number of bays and placement of the two different types of energy absorbing cartridges described herein within the bays. The device shall utilize non-proprietary transition components and hardware for transitioning to a wide range of proprietary and non-proprietary barrier systems. The system shall be made up of independent collapsible bays that are guided and supported by high strength galvanized steel cables. The system’s energy dissipating capacity shall be achieved using energy absorbing cartridges. All length/width configurations shall be constructible using the same basic parts.

The foundation system shall consist of two cables, a back support, and front cable anchors of various designs for different specific site conditions. The back support and cable anchors shall be manufactured using ASTM A36 steel and shall be galvanized per ASTM A123. The fasteners for these components shall be Class 5.8 (Grade 2) or greater and shall be galvanized per ASTM 153. All washers shall be hardened. The cables shall be one (1) inch (25 mm) in diameter, minimum, and shall be galvanized per ASTM A603.

Bays shall be separated by Front Supports, Middle Supports, and Bulkheads of various widths as required. The Supports, Bulkheads, and cable guides shall incorporate modular bolted on cable guides for the steel cables. The Supports and Bulkheads shall be manufactured using ASTM A36 steel and shall be galvanized per ASTM A123. The fasteners for these components shall be Class 5.8 (Grade 2) or greater and shall be galvanized per ASTM 153. All washers shall be hardened.

Each bay shall be enclosed on each side by steel thrie-beam shaped Sliding Panels. The panels shall be bolted to the Supports and Bulkheads using sliding bolts. End Panels shall be used at the rear end of the device. The End Panels shall be attached to the back support and the last bay’s Sliding Panel through Pipe Panel Mounts which provide mounting points for transition components. The Pipe Panel Mounts shall be bolted to the Back Support. Sliding and End Panels shall be fabricated from steel conforming to AASHTO M180 Class B. Sliding Bolts shall be cast from ASTM 1045 HT steel and shall be galvanized per ASTM A123. Pipe Panel Mounts shall be fabricated from steel conforming to ASTM A513, Type 5. The fasteners for these components shall be Class 5.8 (Grade 2) or greater and shall be galvanized per ASTM 153. All washers shall be hardened.

The system shall incorporate a nose piece and flexible front support legs mounted to the front support. The front support legs shall be manufactured from either synthetic or natural rubber or polyurethane. The nose piece shall be fabricated from polyurethane. The fasteners for these components shall be Class 5.8 (Grade 2) or greater and shall be galvanized per ASTM 153. All washers shall be hardened.

The system shall utilize two types of energy absorbing cartridges. The cartridges shall be cylindrical shaped and shall measure approximately 30-1/2 in (775 mm) in length and 25 in (635 mm) in diameter. Each cartridge shall weight approximately 35 lb (16 kg). The cartridges shall be manufactured using a specially formulated High Density Cross-linked polyethylene.

The device shall be attached to a foundation. Foundation and attachment specifications and details shall be provided by the manufacturer. The anchor design shall achieve a pull out strength of 25,000 lb (12,000 kg) and shear strength of 19,000 lb (8,500 kg).

715.41.9-Product Submission and Approval: Traffic Safety Devices to be considered for inclusion on the Division’s Traffic Safety Device APL shall be submitted to the Materials Division following the current procedures specified in MP 106.00.02.
The manufacturer should include all relevant documentation and information, including but not limited to product data sheets, product flyers, manufacturer product specifications and recommendations, product bulletins, product manuals, engineering drawings, crash testing performance documentation, and any other requested information such as repair time and repair part cost data.

The manufacturer shall be required to demonstrate the crashworthiness of the device as part of the submittal requesting consideration for including the device on the Division APL. Devices shall be demonstrable to meet the previously specified crash testing standards by means specified in official guidance issued by the WVDOH.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 720
SMOOTHNESS TESTING

720.1-DESCRIPTION:
To measure and evaluate the ride quality of pavement surfaces in accordance with the International Roughness Index (IRI), as well as the most recent forms of AASHTO R-56, AASHTO M328, and AASHTO R-57.

720.2-EQUIPMENT:
720.2.1-High-Speed or Low Speed Inertial Profiler: Provide a high-speed or low speed inertial profiler for measuring and evaluating the ride quality of pavement surfaces. The inertial profiler shall be certified at a facility approved by the Materials Control, Soils and Testing Division (MCS&T). Certification facilities should conduct the evaluation in accordance with the most recent edition of AASHTO R-56 “Standard Practice for Certification of Inertial Profiling Systems”. All inertial profilers shall be maintained in accordance with the most recent edition of AASHTO M328 “Standard Specifications for Inertial Profiler” Calibration and verification shall be done in accordance with MP 720.10.0. The Contractor shall submit equipment certification documentation after becoming certified or after recertification. Proof of equipment certification shall be available upon request. A current decal provided by the certification facility shall be displayed on the inertial profiler to indicate equipment certification compliance.

720.2.2-Inertial Profiler Operator Certification: Certification through the Material Control, Soils and Testing Division shall be required to operate an inertial profiler in the State of West Virginia. The operator shall pass a written exam administered by MCS&T. All operators receiving a passing score on the written exam will be placed on the WVDOH Materials Certification Directory that is found on the MCS&T webpage Material Division’s Approved Source List “WVDOH Certified Profilers”. Certification shall be for a period of three years. Certified operators shall submit an application for certification renewal to MCS&T. After reviewing the certification renewal application, MCS&T may issue the operator a new four-year certification or may require the operator to retest for certification renewal.

720.3-RIDE QUALITY TESTING
720.3.1-Quality Control (QC) Testing: QC testing on NHS routes is the responsibility of the Contractor. QC testing shall be completed in accordance with MP 720.10.01 Section 8 no
later than fourteen ten (140) calendar days after all lanes are continuously open to traffic. Data collection shall be done by a certified inertial profiler and certified inertial profiler operator (See 720.2.1 and 720.2.1.). Collected profile data shall be submitted via email to the project engineer in accordance with MP 720.10.01 Section 10.ohmes@wv.gov within five (5) calendar days of testing. Profile data shall be collected and submitted in accordance with the most recent edition of AASHTO R-57.

720.3.2-Quality Assurance (QA) Testing: QA testing is the responsibility of the Division. The Engineer shall submit a “Bridge and Pavement Testing Request Form” form to MCS&T via email, within five (5) calendar days after all lanes are continuously open to traffic stages of paving are completed. Within ten-14 (140) calendar working days from receiving the request, the Division will conduct QA testing. The Division will use a certified inertial profiler and certified operator for QA testing.

720.3.3-Quality Assurance Verification (QAV) Testing: QAV testing is the responsibility of the Division. The Division’s profile data and the Contractor’s profile data will be compared to determine the IRI differences. Final project price adjustments will be made using the Contractor’s profile data if the IRI differences are within the allowable limits outlined in Table 720.3.3.

<table>
<thead>
<tr>
<th>Contractor’s IRI Mean (in/mi)</th>
<th>Maximum Allowable Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.0 or Less</td>
<td>8.5% of Contractor’s IRI Mean</td>
</tr>
<tr>
<td>50.1 to 150.0</td>
<td>6.0% of Contractor’s IRI Mean</td>
</tr>
<tr>
<td>150.1 or Greater</td>
<td>7.0% of Contractor’s IRI Mean</td>
</tr>
</tbody>
</table>

720.3.4-Referee Testing: Referee testing is the responsibility of the Division. If the QAV testing IRI differences does not meet the maximum allowable difference from Table 720.4.3, the Division will perform referee testing using a certified inertial profiler and a certified inertial profiler operator in accordance with the most recent edition of AASHTO R56 “Standard Practice for Certification of Inertial Profiling Systems”. The profile data from the referee test shall be used in determining the final project price adjustments.

720.3.4.1-Referee Data: If the referee test data still does not meet the allowable IRI differences MCS&T can recommend the Contractor recertify their inertial profiler and inertial profiler operator that was used on the project.

720.3.5-Testing After Repairs: Should repairs be needed to the surface from the defects in the pavement prior to project closeout, QA and QAV testing shall be conducted after all repairs are made. This will be the final tested value for the lot.

720.4-RIDE QUALITY ANALYSIS

720.4.1-Data Location: The average IRI number used in ride quality analysis shall be the average international mean roughness number-index (MRI) of the two wheel paths, which is the average IRI of both the left and right wheel path. Analysis shall be done in accordance with MP 720.10.01 Section 9.
720.4.2-Omitted Sections: Bridge Structures and any sections tested which are not included in the pavement project shall be removed from the Smoothness Analysis. These removed bridges and sections shall also include a Lead-In and Lead-Out distance to be removed from the Ride Quality Analysis. The Lead-In distance shall be two hundred (200) feet and the Lead-Out distance shall be two hundred (200) feet.

720.4.3-Sampling Lots: The pavement shall be divided into sampling lots of one-tenth (0.1) lane mile each. Each Lot shall have a smoothness measurement, expressed in inches per mile (in./mi.).

720.4.3.1-Special Cases for Sampling Lots Less Than One-Tenth (0.1) Lane Mile: In some cases, sampling, lots of one tenth (0.1) lane mile will not be attainable. These cases include areas at the end of the project as well as areas that are before the ‘lead in’ length of bridges. If these areas are less than five-hundredths (0.05) of a lane mile that will be eliminated from Smoothness analysis. If these areas are more than five-hundredths (0.05 mile) lane mile these areas will be included in analysis and pay adjustments will be prorated to the nearest one hundredth (0.01) mile. This shall apply to all projects governed by Section 720.

720.4.4-Rounding: IRI numbers shall be rounded to the nearest whole number. Rounding of IRI shall be done in accordance with MP 109.01.01, “Rounding of Numbers”.

720.5-NATIONAL HIGHWAY SYSTEM (NHS) PAVEMENT PROJECT:
Pavement projects located on any NHS route and greater than 0.2 miles of continuous new pavement shall be tested with a high-speed or low speed inertial profiler certified in accordance with Section 720.2.

720.5.1-Determining National Highway System Routes: The “West Virginia NHS Routes by County” Section of the most recent Annual Roadway Inventory Statistics document should be used when determining if a route is on the National Highway System. This document can be found online at:
http://www.transportation.wv.gov/highways/programplanning/hti/Highway_Data_Services/Pages/DataResources.aspx

720.5.2-Schedule 1 NHS Pavement Projects: NHS pavement projects with a pavement thickness of four (4) inches or greater shall be classified as Schedule 1 NHS Pavement Projects. The final price adjustments for Schedule 1 NHS Pavement Projects shall be determined using the calculations shown in Table 720.5.2.

<table>
<thead>
<tr>
<th>IRI for each 0.1-mile section (in/mi)</th>
<th>Price Adjustment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.0 or Less</td>
<td>+600</td>
</tr>
<tr>
<td>30.1 to 60.0</td>
<td>-20(IRI) + 1,200</td>
</tr>
<tr>
<td>60.1 to 65.0</td>
<td>0</td>
</tr>
<tr>
<td>65.1 to 95.0</td>
<td>-20(IRI) + 1,300</td>
</tr>
<tr>
<td>95.1 or Greater</td>
<td>Corrective Action Required</td>
</tr>
</tbody>
</table>
720.5.2.1-Corrective Action for Schedule 1 NHS Pavement Projects: Corrective action shall be required for Schedule 1 NHS Pavement Projects having an IRI greater than 95.1 in/mi. Corrective action shall be performed using diamond grinding, micro milling, or other work methods approved by the Engineer.

720.5.3-Schedule 2 NHS Pavement Projects: NHS pavement projects with a pavement thickness three (3) inches or greater and less than four (4) inches shall be classified as Schedule 2 NHS Pavement Projects. The final price adjustments for Schedule 2 NHS Pavement Projects shall be determined using the calculations shown in Table 720.5.3.

<table>
<thead>
<tr>
<th>IRI for each 0.1-mile section (in/mi)</th>
<th>Price Adjustment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.0 or Less</td>
<td>+600</td>
</tr>
<tr>
<td>46.1 to 76.0</td>
<td>-20(IRI) + 1,520</td>
</tr>
<tr>
<td>76.1 to 80.0</td>
<td>0</td>
</tr>
<tr>
<td>80.1 to 120.0</td>
<td>1,200 - 15(IRI)</td>
</tr>
<tr>
<td>120.1 or Greater</td>
<td>-600</td>
</tr>
</tbody>
</table>

720.5.4-Schedule 3 NHS Pavement Projects: NHS pavement projects with a pavement thickness less than three (3) inches and more than one (1) inch shall be classified as Schedule 3 NHS Pavement Projects. The final price adjustments for Schedule 3 NHS Pavement Projects shall be determined using the calculations shown in Table 720.5.3.

<table>
<thead>
<tr>
<th>IRI for each 0.1-mile section (in/mi)</th>
<th>Price Adjustment ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>46.0 or Less</td>
<td>+300</td>
</tr>
<tr>
<td>46.1 to 76.0</td>
<td>-10(IRI) + 760</td>
</tr>
<tr>
<td>76.1 or Greater</td>
<td>0</td>
</tr>
</tbody>
</table>

720.6-NON-NATIONAL HIGHWAY SYSTEM PAVEMENT PROJECTS: Pavement projects located on any Non-NHS routes shall be tested with equipment outlined in 720.2.1, 720.2.2 and 720.3 if the project meets all five of the following requirements:
1. **Resurfacing is the primary project type**
2. Greater than 0.2 miles of continuous pavement,
3. **Sixteen (16) feet or wider Edge lines and center line on the new pavement in accordance with Section 663.**
4. Thickness of one inch (1) or more of new pavement - (including scratch if used)
5. Minimum Average Daily Traffic (ADT) of one hundred (100)

720.6.1-Ride Quality Analysis Before Project Completion: Non-NHS pavement projects shall be tested before the pavement project begins and the pavement project is completed.
720.6.1-Data Source Collection Before Beginning Project: The data collection before project begins may be collected from one of the following sources: (a) The Division’s highspeed or low speed inertial profiler, (b) The Contractor’s data if the data was collected with a certified inertial profiler and certified inertial profiler operator, (c) The Division’s data base.

720.6.2-Data Source Collection After Project Completion: The data source collection after project completion shall be collected by the Division’s high-speed or low speed inertial profiler as referenced in 720.3.2. On non-NHS routes Quality Control Testing is optional for the contractor.

720.6.3-Final Price Adjustments: Final price adjustment incentives shall be calculated using percent improvement. 0.1-mile sections of after project completion data with an IRI of 170 in/mi or greater will be ineligible for final price adjustment and if the average percent improvement for the entire project is less than fifty percent (50%) the project will not be eligible for price adjustments. If the average percent improvement is more than fifty percent the final price adjustments for Non-NHS Pavement Projects shall be determined using the calculations shown in Table 720.6.5.

<table>
<thead>
<tr>
<th>Percent Improvement (%)</th>
<th>Price Adjustment Incentive ($ per 0.1-mile Section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>75.0 or Greater</td>
<td>+450</td>
</tr>
<tr>
<td>50.1 to 74.9</td>
<td>18 (Percent Improvement) - 900</td>
</tr>
<tr>
<td>50.0 or Less</td>
<td>0</td>
</tr>
</tbody>
</table>

Where:
Percent Improvement (%) = \[
\frac{\text{Before IRI of Lot} - \text{After IRI of same Lot}}{\text{Before IRI of Lot}} \times 100
\]

720.7-PROJECT THAT DO NOT FALL UNDER PREVIOUS CHARACTERIZATIONS:
At the discretion of the Engineer pavement projects not falling into any of the other classifications shall be measured and evaluated for ride quality analysis under the direction of the Engineer. If recommended by the Engineer this shall be done by the Contractor with a 10-foot straightedge. There will not be any pay adjustments based on Smoothness for these projects.

---

720.7.1-New Pavement That is One (1) Inch or Less in Thickness: Pavement projects that are less than one (1) inch of new pavement will not be tested for Smoothness.
DETERMINE THE CONTENTS OF SUBSECTION 707.15.2 AND REPLACE WITH THE FOLLOWING:

707.15.2.1-The effects of using hydration control stabilizing admixtures may vary widely with different types of cement, cement from different mills, aggregate proportions, aggregates from different sources and of different gradation, and changes in water-cement ratio. Therefore, no hydration control stabilizing admixture shall be used until the concrete of the specified class, designed in accordance with these Specifications and made with the ingredients proposed for use by the Contractor, including hydration control stabilizing admixtures as specified or permitted under this Specification, is shown to meet the requirements of AASHTO M 194 for water reduction and compressive strength increases at ages 3, 7, and 28 days.

707.15.2.2-In order for a concrete mix design, containing a hydration control stabilizing admixture, to be considered for the allowable concrete discharge time extension for excessive haul time, as outlined in Section 601.7, the additional following extended discharge time testing is required in that subject mix design.

Upon completion of the mixing of at least one of the trial batches at the minimum cement factor, for the subject mix design, as required in MP 711.03.23, air content and slump tests in accordance with Section 601.4.1 shall be performed on that trial batch of plastic concrete. A test to establish the initial and final times of setting of the concrete mix shall also be performed, in accordance with ASTM C403. The air content and slump tests shall then be repeated at 45-minute intervals, until a period of 3-hours after the completion of mixing has elapsed.

The value obtained by any of the air content tests during the 3-hour period shall not vary, from the value obtained by the initial air content test, by more than 2.5 percentage points.

The value obtained by any of the slump tests during the 3-hour period shall not vary, from the value obtained by the initial slump test, by more than 1.75 inches (445 mm).
The results of all these tests shall be included, along with all the other information required in MP 711.03.23, when the subject mix design is submitted for approval.

When more than one mix design, for the same Producer/Supplier, is submitted for approval on the same day, only one set of extended discharge time tests, as outlined in paragraphs two through five of this sub-section, will be required for that entire group of mix designs. That one set of extended discharge time tests, for the subject group of mix designs, shall be performed on the mix design, in that group of mix designs, which has the highest cementitious material content. If the results of that set of extended discharge time tests meet the requirements of this sub-section, then all of the mix designs, in that group of mix designs submitted on that same day for that Producer/Supplier, shall be approved for use with the extended discharge time.

707.15.2.3-The subject concrete mix design, and the concrete mix used during construction, shall contain the quantity of admixture recommended by the manufacturer at the prevailing temperature.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

SECTION 105
CONTROL OF WORK

105.2 – PLANS AND WORKING DRAWINGS:

ADD THE FOLLOWING:

105.2.2 – Dates of Governing Specifications and Standard Details: These provisions are intended to provide guidance as to which edition of the West Virginia Department of Transportation, Division of Highways, Standard Specifications Roads and Bridges and Volumes I and II West Virginia Department of Transportation, Division of Highways, Standard Details Books are applicable to this Project.

105.2.2.1 – Item Number and Description: The item number and description shown in the Schedule of Items will govern over item number and/or description shown within the plans.

105.2.2.2 – Standard Details Dates: The West Virginia Department of Transportation, Division of Highways, Standard Details Volume I, dated May 2016 and Volume II, dated January 1, 1994 shall apply to this project.

Specifications can be found on the following website:
http://www.transportation.wv.gov/highways/contractadmin/specifications/Pages/default.aspx

Standard Detail drawings can be found on the following website:
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

SUPPLEMENTAL SPECIFICATION

FOR

SECTION 601
STRUCTURAL CONCRETE

601.4-TESTING:

601.4.2-Contractor's Quality Control:

DELETE THE CONTENTS OF SUBSECTION AND REPLACE WITH THE FOLLOWING:

Quality control of the structural concrete is the responsibility of the Contractor as designated in MP 601.03.50. The Contractor shall maintain equipment and qualified personnel, including at least one certified Portland cement concrete technician who shall direct all field inspection, sampling and testing necessary to determine the magnitude of the various properties of concrete governed by the Specifications and shall maintain these properties within the limits of this Specification. The Contractor’s personnel who conducts the field sampling and testing shall be a certified Portland Cement Concrete Inspector. The quality control plan designated in MP 601.03.50 shall be submitted to the Engineer at the preconstruction conference. Work shall not begin until the plan is reviewed for conformance with the contract documents.

A certified Portland cement concrete (PCC) Technician shall be present at the Concrete Supplier during all batching operations and shall directly oversee those batching operations and any subsequent necessary mix adjustments. A certified PCC technician may perform this work from an alternate remote location, provided that the PCC Technician uses District approved concrete QC batching software to directly oversee all batching operations and perform any subsequent necessary mix adjustments. The details of this remote monitoring shall be outlined in the Quality Control Plan for plant operations.

The Contractor shall provide a copy of the quality control test results to the Supplier of the concrete which was tested within 48 hours of the completion of the test.

Any Agency or Laboratory which tests Contractor Quality Control concrete compressive strength specimens, that may be used for acceptance by the Division, shall be evaluated by the Cement and Concrete Reference Laboratory (CCRL) and certified as meeting the all the requirements of ASTM C1077 pertaining to testing concrete cylinders.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 601
STRUCTURAL CONCRETE

601.7-MIXING:

DELETE THE CONTENTS OF SUBSECTION AND REPLACE WITH THE FOLLOWING:

Concrete may be central-mixed, truck-mixed, or shrink-mixed as defined in AASHTO M 157 and will be designated as ready-mixed concrete. The production of ready-mixed concrete shall meet the applicable requirements of AASHTO M 157, paragraphs ten and eleven, except as otherwise specified.

Concrete for incidental construction items may be made by volumetric batching and continuous mixing as designated in ASTM C 685, except as otherwise specified. Concrete produced by this method will not be permitted in bridge, box culvert, pavement, or retaining wall construction.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of work and discharge completed within one and one-half hours after the addition of the cement to the aggregates. Each batch of the concrete delivered at the job site shall be accompanied by a batch ticket that contains complete batching information, including the batch weights (or batch volume, in the case of water) of all materials in that batch of concrete. In adverse weather or under other conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85° F (30° C) or above, the time between the introduction of the cement to the aggregates and the discharge shall not exceed one hour. When a truck mixer is used for the complete mixing of the concrete, the mixing operation shall begin within one hour after the cement has been added to the aggregate.

When placing concrete at remote locations, due to excessive haul time to the site of work from the closest approved batch plant, and when discharge of the concrete within the time limits specified in the previous paragraph is not possible, or in other circumstances when approved by the Engineer, a concrete mix that includes a hydration control stabilizing admixture may be used to extend the allowable concrete discharge time. The subject concrete mix containing this admixture must be approved in accordance with section 601.3.1, and the hydration control stabilizing admixture must be approved in accordance with section 707.15. When conditions are such that a hydration control stabilizing admixture is used, the allowable time between the introduction of the cement to the aggregates and discharge of the concrete shall be increased to
three hours. The limit of 300 maximum revolutions (pertaining to truck mixers or agitators) specified in AASHTO M 157 may be waived when hydration control stabilizing admixtures are used, provided that no additional water is added prior to discharge of the concrete. A single batch of concrete containing a hydration control stabilizing admixture may not be discharged on more than one project. When a mix, containing a hydration control stabilizing admixture is used, and that mix has been approved for the three-hour discharge time, the reduced discharge time required when concrete temperatures are 85 °F (30 °C) or above, and specified in the third paragraph of this sub-section, shall not apply, provided that the concrete supplier has adjusted the hydration control stabilizing admixture dosage rate to account for that higher concrete temperature.

The addition of water after completion of initial mixing will not be permitted, except that when concrete is delivered in truck mixers, additional water may be added to adjust to a specified consistency. In this event, a minimum of 20 additional revolutions of the truck mixer drum at mixing speed shall be required before discharge of any concrete; the maximum allowable time between the addition of the cement to the aggregates and the discharge of the batch shall not be exceeded. Concrete that is not within the specified consistency limits at the time of placement shall not be used. When superplasticizer is used to adjust the consistency of a mix at the job site, as outlined in Section 601.3.2.1, no additional consistency adjustment of that mix with water shall be permitted.

For all classes of concrete except Class H and concrete for specialized overlays, the total amount of water in a concrete mix, including any water added at the job site, shall not be more than the amount which would cause the water-cement ratio (w/c) of that concrete mix to exceed the w/c which corresponds to the Mix Design Approved Strength, as outlined in Section 5.4 of MP 711.03.23. The maximum water amount shall also be shown in Attachment 4 or 5 of MP 711.03.23 for all approved concrete mix designs. However, under no circumstances shall the w/c in Table 601.3.1A be exceeded.

Shrink-mixed concrete is a ready-mixed concrete which is initially and partially mixed in a central mix plant and lastly mixed to completion in a truck mixer while in transit to or after arrival at the job site. Shrink-mixed concrete will be allowed for use in the work if specified in the Contract.
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SUPPLEMENTAL SPECIFICATION
FOR
SECTION 601
STRUCTURAL CONCRETE

601.8-FORMS:
601.8.7—Removal of Forms and Construction of Superimposed Elements:

DELETE THE CONTENTS OF THE SUBSECTION AND REPLACE WITH THE FOLLOWING:

The forms for any portion of the structure shall not be removed until the concrete is strong enough to prevent damage. Methods of form removal likely to cause overstressing of the concrete shall not be used.

The minimum requirements for removal of forms or supports and the construction of superimposed elements shall be as specified in Table 601.8.7.

Due to continuity of reinforcement between placements and other issues, adjacent bridge deck placements shall be considered superimposed elements and must meet the minimum strength requirement in Table 601.8.7 before an adjacent placement in the sequence may be placed.

In lieu of field cured cylinders for the determination of compressive strength required for from removal and construction of superimposed elements, the Contractor may use the Maturity Method for the estimation of concrete strength as outlined in MP 601.04.21.

| TABLE 601.8.7 |
| Requirements for Removal of Forms and Construction of Superimposed Elements |
| Structural Element | Removal of Forms | Placing Concrete In Superimposed Elements |
| | Compressive Strength-psi (Mpa) | Compressive Strength-psi (Mpa) |
| Bridge Decks | 2000 (14.0) | 3000 (21) |
| Columns | 2000 (14.0) | 2000 (14.0) |
| Walls & Beams | 2000 (14.0) | 2000 (14.0) |
| Footings | 500 (3.5) | 2000 (14.0) |
| Components Supported By Falsework | 3000 (21) | 3000 (21) |
| Parapets | 2000 (14.0) | (See 601.11) |
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION
FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

SECTION 603
PRESTRESSED CONCRETE MEMBERS

ADD THE FOLLOWING TO SUB-SECTION:

603.19-POST-TENSIONING:
The work under this section shall consist of furnishing, installing, stressing, and grouting of post-tensioning tendons in accordance with the details shown on the Plans, Section 603 of the Specifications, and this Special Provision.

603.19.1-Description: Furnish and install all post-tensioning systems and any other pertinent items necessary for the prestressing system used, including but not limited to ducts, anchorage assemblies and supplementary reinforcement. Furnish all components of a post-tensioning system, including deviators for future post-tensioning, but not necessarily the prestressing steel, from a single supplier.

Install prestressing steel, which may be strands or bars, through ducts in the concrete. Stress to a predetermined load and anchor directly against the hardened concrete. Grout ducts to fill all voids and install protection at end anchorages.

Submit shop and working drawings and manuals in accordance with Section 603.19.1.2 of this Special Provision and Section 105 of the Standard Specification. The Contractor’s Specialty Engineer shall produce all shop drawings related to post-tensioning which shall bear the signature and seal of the responsible engineer.

603.19.1.1-Qualifications and Inspection: Perform all post-tensioning field operations under the direct supervision (crew foreman) of a qualified post-tensioning and grouting technician. Provide project personnel, a crew foreman and crew members in accordance with Section 603.19.1.6 of this Special Provision. Conduct all stressing and grouting operations in the presence of the Engineer.

603.19.1.2-Shop Drawings: Prepare shop drawings to address all requirements stated in Section 105.2 of the Standard Specifications, contract plans and the requirements stated herein.
The Contractor will be required to submit checked detailed Shop Drawings, which include, but are not limited to, the following:

1. A complete description of all details covering each of the post-tensioning systems proposed for permanent tendons.
2. Prestressing details shall include method, sequence, and procedure of prestressing, securing tendons, release procedures and equipment.
3. Limitations of the selected post-tensioning system, tendon geometry and location of the tendons, specifics of the post-tensioning steel, anchorage devices, sheathing material, and accessory items to be used.
4. Anchorage system details, size and type of ducts for all post-tensioning tendons and their horizontal and vertical profiles. Duct supports and grout tubes, inlets, outlets, high point outlet inspection details, anchorage inspection details and permanent grout caps, protection system materials and application limits.
5. A table giving jacking sequence, jacking forces and initial elongation, and estimates of anchor sets of the tendons at each stage of erection for all post-tensioning.
6. Parameters to be used to calculate the typical tendon force such as expected friction coefficients, anchor set, and post-tensioning relaxation curves.
7. Certified copies of reports covering tests performed on post-tensioning steel and anchorages devices as required by Section 603.19.1.5 of this Special Provision.
8. The submittal shall also include information regarding the grout mix design, the method of mixing and placing the grout and the type and capacity of equipment to be used.
9. The details of the anchorage systems shall be shown including local zone reinforcement steel required to resist the concrete bursting stress in the vicinity of the anchorage assemblies.

603.19.1.3-Alternate Post-Tensioning Designs: Alternate designs using a post-tensioning scheme other than that shown on the plans may be submitted for the Engineer’s approval provided that the proposed alternate scheme fulfills the following requirements:

1. The prestress system is a type described in and meeting the requirements of this Special Provision.
2. The net compressive stress in the concrete after all losses is at least as large as that provided by the post-tensioning shown on the plans.
3. The distribution of individual tendons at each cross section generally conforms to the distribution shown on the plans.
4. The ultimate strength of the structure with the proposed post-tensioning scheme meets the requirements of the “AASHTO LRFD Bridge Design Specifications” Current Edition with all applicable interims and shall be equivalent to or greater than the ultimate strength provided by the original design.
(5) Stresses in the concrete and prestressing steel at all sections and at all stages of construction meet the requirements of the Design Criteria noted on the plans.

(6) All provisions of the Design Criteria noted on the plans shall be satisfied.

(7) The Contractor fully designs and details all the elements affected by the alternative post-tensioning system.

(8) The Contractor submits complete shop drawings including post-tensioning scheme and system, reinforcing steel, and concrete cover; and design calculations (including short and long term prestress losses) for the Engineer’s approval.

(9) Alternative post-tensioning shall be designed and sealed by the responsible Specialty Engineer.

603.19.1.4-Material Storage: Store all materials in a weatherproof building, shed or container until time of use. Maintain storage environment at 65% Relative Humidity or less for all steel products in storage for more than 30 days.

603.19.1.5-Certification of Post-Tensioning System: The manufacturer of the post-tensioning system must submit test results to the Engineer and include certified test reports from an independent laboratory audited by AASHTO Materials Reference Laboratory (AMRL) which shows the post-tensioning system meets the requirements specified herein. Plastic components shall be tested in a certified independent laboratory accredited through the accreditation program of the Geosynthetic Accreditation Institute (GAI) or the American Association for Laboratory Accreditation (AALA). Certification of test reports may be performed by an independent laboratory outside of the United States of America. This outside laboratory shall be approved by the Engineer prior to commencement of any work on the project. If any component of the post-tensioning system is modified or replaced, after the approval of the Engineer, the entire system must be retested in accordance with the directions stated herein and new certified test reports must be submitted and approved prior to the submission of Shop Drawings. Certified reports received from testing laboratories outside the United States shall be prepared and submitted in a format that can be easily interpreted by the Division.

Perform certification tests for the plastic components on a sample formed or cut from the finished product. Provide the Engineer with a certification that the plastic from the duct sample complies with all requirements of the specified cell class, stress crack rating and the specified amount of antioxidant. Certify to the Engineer that the post-tensioning system being furnished is in compliance with all requirements stated herein.

Ensure all components of a system are stamped with the supplier’s name, trademark, model number and size corresponding to catalog designation.

Prior to installing any post-tensioning hardware, the Contractor shall furnish the Engineer with a certification from the post-tensioning supplier that the system chosen for the project meets all of the requirements stated in this Special Provision, and is the system currently approved with the requirements of this Section. Upon completion of the post-tensioning installation, the contractor shall supply the Engineer a certification that the post-tensioning system supplied was installed without any modification and met the requirements of the contract documents.
Post-tensioning systems which have been tested and approved by the Florida Department of Transportation (FDOT) will be considered as an acceptable alternate to the required testing stated in this Special Provision. A copy of approval letter from FDOT including any details associated with the approval shall be submitted to the Engineer with the Shop Drawings prepared by the post-tensioning system supplier.

603.19.1.6-Project Personnel Qualifications:

603.19.1.6.1-General: Submit qualifications of supervisory personnel to the Engineer. The contractor will not begin construction until the qualifications of supervisory personnel, as set forth herein, have been approved by the Engineer.

603.19.1.6.2-Proof of License or Certification: Contractor personnel that are required to be registered as professional engineers as required herein, must submit a copy of the Professional Engineer license renewal notice/card issued by the licensing agency of the state from which they hold registration. The renewal notice/card must display the license number and must indicate that the license is in force and current. If not shown on the renewal notice/card, the telephone number and address of the licensing agency that issued the renewal notice shall be included with the copy of the renewal notice. Under certain circumstances a West Virginia registration may be required.

603.19.1.6.3-Experience Record: The Contractor shall provide for each project engineer, superintendent, manager, or foreman seeking approval as supervisors a notarized certificate attesting to the completeness and accuracy of the following information in order to substantiate their experience record:

(1) Project owner’s name - such as the State of West Virginia - and telephone number of an owner’s representative, project identification number for the project as well as the following project location information: state, city, county, highway number and feature intersected.

(2) Provide a detailed description of all bridge construction experience and the level of supervisory authority during that experience. Report the duration in weeks, as well as begin and end dates, for each experience period.

(3) Provide the name, address and telephone number of an individual who can verify that the experience being reported is accurate. This individual should have been an immediate supervisor unless the supervisor cannot be contacted in which case another individual with direct knowledge of the experience is acceptable.

603.19.1.6.4-Concrete Post-Tensioning: The contractor shall ensure the following positions meet the requirements as follows:

603.19.1.6.4.1-Project Engineer: Ensure the Project Engineer is a registered Professional Engineer with a minimum of five (5) years of bridge construction experience. Ensure that a minimum of three (3) years of experience is in concrete post-tensioned box girder construction. Ensure that the three (3) years of experience includes, but is not limited to, erection, safe use of form traveler, design and stabilization of falsework required for concrete post-tensioned box girder construction, post-tensioning and grouting operations
and a minimum of one (1) year as the Project Engineer in responsible charge of post-tensioning related operations.

603.19.1.6.4.2-Project Superintendent/Manager: Ensure the Project Superintendent/Manager has a minimum of ten (10) years of bridge construction experience or is a registered Professional Engineer with five (5) years of bridge construction experience. Ensure that the Project Superintendent/Manager has a minimum of three (3) years of supervisory experience in, but not limited to, erection, safe use of form traveler, design and stabilization of falsework required for concrete post-tensioned box girder construction, post-tensioning and grouting operations and a minimum of one (1) year as the Project Superintendent/Manager in responsible charge of post-tensioning related operations.

603.19.1.6.4.3-Foreman: Ensure the Foreman has a minimum of five (5) years of bridge construction experience with a minimum of two (2) years of experience in post-tensioning related construction and a minimum of one (1) year as the Foreman in responsible charge of post-tensioning related operations. Foreman shall be certified as PTI Level 2 Bonded PT Field Specialist.

603.19.1.6.4.4-Crews for Tendon Installations and Post-Tensioning: Perform all tendon installation and stressing of post-tensioning tendons under the supervision of the Crew Foreman. The Crew Foreman shall be certified as PTI Level 2 Bonded PT Field Specialist. In addition, the Crew Foreman shall have a minimum of three (3) years of job site experience in post-tensioning operations. In addition, the contractor shall provide a minimum of two (2) crew members who are certified PTI Level 2 Bonded PT Field Specialist, but need not necessarily have job-site experience. At least 25% of each crew shall be certified in PTI Level 1 Bonded PT – Field Installation.

603.19.1.6.4.5-Crews for Tendon Grouting: Perform all grouting operations after the stressing of tendons under the supervision of the Crew Foreman. The Crew Foreman shall be certified as PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician. In addition, the Crew Foreman shall have a minimum of three (3) years job site experience in the grouting of post-tensioning tendons. In addition, the Contractor shall provide a minimum of two (2) crew members that shall be certified as PTI Level 2 Bonded PT Field Specialist and ASBI Certified Grouting Technician, but need not necessarily have job-site experience. At least 25% of each crew shall be certified in PTI Level 1 Bonded PT – Field Installation.

603.19.2-Terms Used:
- **Anchorage Assembly:** An assembly of various hardware components that secures a tendon at its ends after it has been stressed imparting the tendon force into the concrete.
- **Anchor Plate:** Any hardware of the anchorage assembly that bears directly on the concrete and transfers the tendon force directly into a structure.
- **Anticipated Set:** The set assumed to occur in the design calculation of the post-tensioning forces at the time of load transfer.
- **Bar:** Post-tensioning bars are high strength steel bars, normally available from 5/8 to 2 1/2 inch diameter and usually threaded with very coarse thread.
Bleed: The autogenous flow of mixing water within or that which emerges from newly placed grout caused by the settlement of the solid materials within the mass.

Coupler: A device used to transfer the prestressing force from one partial length prestressing tendon to another. (Strand couplers are not allowed.)

Duct: Material forming a conduit to accommodate prestressing steel installation and provide an annular space for the grout, which protects the prestressing steel.

Family of Systems: Group of post-tensioning tendon assemblies of various sizes, which use common anchorage devices and design. All components within the family of systems shall be furnished by a single supplier and shall have a common design with varying sizes.

Fluidity: A measure of time, expressed in seconds, necessary for a stated quantity of grout to pass through the orifice of a flow cone.

Grout: A mixture of cementitious materials and water, with or without mineral additives or admixtures, proportioned to produce a pumpable consistency without segregation of the constituents, when injected into the duct to fill the space around the prestressing steel.

GUTS: Guaranteed Ultimate Tensile Strength: This is the tensile strength of the material that can be assured by the manufacturer. GUTS should not be confused with "f PU" the specified ultimate tensile strength (AASHTO LRFD 5.4.4.1).

Grout Cap: A device that contains the grout and forms a protective cover sealing the post-tensioning steel at the anchorage.

Inlet Vent: Tubing or duct used for injection of the grout into the duct.

Outlet Vent: Tubing or duct to allow the escape of air, water, grout and bleed water from the duct.

Post-tensioning: A method of prestressing where tensioning of the tendons occurs after the concrete has reached a specified strength.

Prestressing Steel: The steel element of a post-tensioning tendon which is elongated and anchored to provide the necessary permanent prestressing force.

Post-Tensioning Scheme or Layout: The pattern, size and locations of post-tensioning tendons provided by the Designer on the Contract Plans.

Post-tensioning System: An assembly of specific models of hardware, including but not limited to anchorage assembly, local zone reinforcement, wedge plate, wedges, inlet and outlet vents, couplers, duct, duct connections and grout cap used to construct a tendon of a particular size and type. The entire assembly must meet the system pressure testing requirement.

Pressure Rating: The estimated maximum pressure that water in a duct or duct component can exert continuously with a high degree of certainty that failure of the duct or duct component will not occur (commonly referred to as working pressure).

Set (Also Anchor Set or Wedge Set): Set is the total movement of a point on the strand just behind the anchoring wedges during load transfer from the jack to the permanent anchorages. Set movement is the sum of slippage of the wedges with respect to the anchorage head and the elastic deformation of the anchor components. For bars, set is the total movement of a point on the bar just behind the anchor nut at transfer and is the sum of slippage of the bar and the elastic deformation of the anchor components.

Strand: An assembly of several high strength steel wires wound together. Strands usually have six outer wires helically wound around a single straight wire of a similar diameter.

Tendon: A single or group of prestressing steel elements and their anchorage assemblies imparting prestress forces to a structural member. Also included are ducts, grouting attachments, grout and corrosion protection filler materials or coatings.
**Tendon Size:** The number of individual strands of a certain strand diameter or the diameter of a bar.

**Tendon Type:** The relative location of the tendon to the concrete shape, either internal or external.

**Thixotropic:** The property of a material that enables it to stiffen in a short time while at rest, but also to acquire a lower viscosity when mechanically agitated.

**Wedge Plate:** The hardware that holds the wedges of a multi-strand tendon and transfers the tendon force to the anchorage assembly (commonly referred to as anchor head).

**Wedge:** A conically shaped device that anchors the strand in the wedge plate.

---

**603.19.3-Materials:** Meet the requirements of the following:

- **Wire Strand**
  - AASHTO M203
- **Bar**
  - AASHTO M275
- **Water**
  - Section 715

**603.19.3.1-Prestressing Material:**

**603.19.3.1.1-Prestressing Steel:**

- **Strand:** Unless otherwise noted on the Plans, strand shall be uncoated, Grade 270 (1860 MPa), low relaxation 7-wire strand conforming to the requirements of AASHTO M203.
- **Bar:** Unless otherwise noted on the Plans, bar shall be uncoated, Grade 150 (1035 MPa), high strength, coarse thread bar conforming to the requirements of AASHTO M275, TYPE II.

**603.19.3.1.2-Post-Tensioning System:** Use only the approved post-tensioning system as stated in Section 603.19.1.5 of this Special Provision, and of the proper size and type to construct tendons as shown on the Contract Documents. The use of bar couplers on the project is subject to written approval by the Engineer. Substitution of components of an approved post-tensioning system is not allowed. Use only post-tensioning systems that utilize tendons fully encapsulated in anchorages and ducts. Systems that transfer prestress force by bonding the prestress steel strand directly to concrete are not allowed. Embedded anchors for bars are permitted. Systems utilizing formed, ungrouted voids or “diablos” will be permitted for future post-tensioning only.

**603.19.3.1.3-Post-Tensioning Anchorages:** The Contractor shall ensure that the anchorages develop at least 95% of the actual ultimate tensile strength of the prestressing steel, when tested in an unbonded state, without exceeding the anticipated set.

Anchorages shall be designed so that the average concrete bearing stress and local zone reinforcement complies with the “AASHTO LRFD Bridge Design Specifications”, Current Edition with all applicable Interims. Test and provide written certification that anchorages meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications. The design and furnishing of local zone reinforcement, in addition to the reinforcement shown in the plans, shall be the responsibility of the Contractor with no additional compensation.

The body of all future post-tensioning anchorages shall be galvanized in accordance with AASHTO M111. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing
surface and wedge plate from ferrous metal. Equip all anchorages with a permanent grout cap that is vented and bolted to the anchorage.

Extreme care shall be taken so that bends in deviators/diablos conform to the radii shown on the plans and that the deviators/diablos are properly positioned. The Contractor shall demonstrate to the Engineer that deviators/diablos are correctly positioned after concrete placement is complete by stringing lines along future tendon paths between anchorages and deviators. Improperly bent or positioned deviators/diablos shall be rejected and shall be repaired or replaced by the Contractor.

Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

Place anchorages with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve a dual function of grout outlet and post-grouting inspection access. The geometry of the grout outlets must facilitate being drilled using a 3/8” diameter straight bit to facilitate endoscope inspection directly behind the anchor plate. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

Trumpets associated with anchorages will be made of either ferrous metal or polypropylene plastic material conforming to the requirements stated in Section 603.19.3.1.6.4. The thickness of the trumpet at the transition location (choke point) will not be less than the thickness of the duct as established in Section 603.19.3.1.6.4. Alternately, the trumpet material may be a polyethylene or polyolefin containing antioxidant(s) with a minimum Oxidative Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours.

603.19.3.1.4-Inlets, Outlets, Valves and Plugs: Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A240, Type 316 stainless steel, nylon or polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Products made from polyolefin shall contain antioxidant(s) with a minimum Oxidative Induction Time (OIT) according to ASTM D3895 of not less than 20 minutes. Test the remolded finished polyolefin material for stress crack resistance using ASTM F2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours. All inlets and outlets will be equipped with pressure rated mechanical shut-off valves or plugs. Inlets, outlets, valves and plugs will be rated for a minimum pressure rating of 150 psi. Use inlets and outlets with a minimum inside diameter of 3/4 inch (20 mm) for tendons of five or more strands and 3/8 inch (10 mm) for single bar tendons and four-strand tendons.

603.19.3.1.5-Permanent Grout Caps: Use permanent grout caps made from fiber reinforced polymer or ASTM A240 Type 316L stainless steel. The resins used in the fiber-reinforced polymer shall be either nylon, Acrylonitrile Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength...
not less than 10,000 psi with UV stabilizer added). Seal the cap with O-ring seals or precision fitted flat gaskets placed against the bearing plate. Place a grout vent on the top of the cap. Grout caps must be rated for a minimum pressure rating of 150 psi. Use ASTM A240 Type 316L stainless steel bolts to attach the cap to the anchorage. When stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

603.19.3.1.6-Duct and Pipe:

603.19.3.1.6.1-General: Use only corrugated plastic duct for all internal tendons. Ensure that all connectors, connections and components of post-tensioning system hardware are air and watertight and pass the pressure test requirements herein. The use of diablos is allowed for future post-tensioning only. The Contractor shall provide connectors for the future tendon’s ducts at the diablos located at anchorages for future tendons.

Ducts and pipes shall be sufficiently rigid to withstand placement of concrete, grouting, and construction loads without damage or excessive deformation, and shall be air and watertight. Ducts shall bend without crimping or flattening, and shall have sufficient strength to maintain their shape and correct alignment during concrete placement. Also, ducts and all connections shall be capable of withstanding the pressure required for pre-grouting air pressure test.

603.19.3.1.6.2-Duct and Pipe Minimum Diameter: For prestressing bars, provide ducts with a minimum internal diameter of at least 1/2 inch larger than the outside diameter of the bar, measured across the deformations.

For multi-strand tendons, provide ducts with a minimum cross-sectional area 2 1/2 times the cross-sectional area of the prestressing steel.

603.19.3.1.6.3-Steel Pipes: Use galvanized schedule 40 steel pipes conforming to ASTM A-53, Grade B where shown in the plans. Ensure that steel pipes used in the tendon anchorage zones are equipped with shear transfer devices. Test and provide written certification that the shear transfer mechanism can resist at least 68% of the tendon GUTS in a shear transfer pull-out test described below:

Shear Transfer Mechanism Pullout Test Procedure:

1. Cast anchorage, shear transfer mechanism and duct in a test block of concrete with minimum dimensions of 2’-6” x 2’-6” x Required Diaphragm Length (6 ft. min.)
2. Stress tendon to 80% GUTS. Grout tendon.
3. Transfer force from wedge plate to shear transfer mechanism. Alternative procedures to safely obtain the required resistance force for the shear transfer mechanism may be used.
4. Measure tendon release force. (Must be greater than 68% of tendon GUTS)
5. Remove shim plates from behind anchor head and transfer tendon force through grout/shear transfer mechanism into test block.
6. Record lowest transfer force measured over a sustained period of one hour. Use tested shear transfer devices.
603.19.3.1.6.4-Corrugated Plastic Duct:  Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts.

Use corrugated duct manufactured from non-colored, unfilled polypropylene meeting the requirements of ASTM D4101 “Standard Specification for Polypropylene Injection and Extrusion Materials” with a cell classification range of PP0340B44544 to PP0340B65884. The duct shall be white in color containing antioxidant(s) with a minimum Oxidative Induction Time (OIT) according to ASTM D3895 of 20 minutes and containing a non-yellowing light stabilizer. Furnish duct with a minimum thickness as defined in the following table:

<table>
<thead>
<tr>
<th>Duct Shape</th>
<th>Duct Diameter</th>
<th>Duct Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat</td>
<td>any size</td>
<td>0.08 inches (2.0 mm)</td>
</tr>
<tr>
<td>Round</td>
<td>3.0 inches (76 mm)</td>
<td>0.10 inches (2.5 mm)</td>
</tr>
<tr>
<td>Round</td>
<td>4.0 inches (100 mm)</td>
<td>0.12 inches (3.0 mm)</td>
</tr>
<tr>
<td>Round</td>
<td>1 5/8 inches (47 mm)</td>
<td>0.12 inches (3.0 mm)</td>
</tr>
</tbody>
</table>

603.19.3.1.6.4.1-Testing Requirements for Corrugated Plastic Duct:  Ensure that the duct system components and accessories meet the requirements of Chapter 4, Articles 4.1 through 4.1.8 of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning” as modified herein.

The requirements in FIB Technical Report, Bulletin 7, are modified as follows:

(a) Conduct the lateral load resistance test (FIB 4.1.4), without the use of a duct stiffener plate, using a load of 150 lbs. (667 N) for all sizes.

(b) Wear resistance of duct (FIB 4.1.7) must not be less than 0.06 in (1.5 mm) for duct up to 3.35 inches in diameter and not less than 0.08 inch (2 mm) for duct greater than 3.35 inches in diameter.

(c) Bond length test (FIB 4.1.8) must achieve 40 % GUTS in a maximum length of 16 duct diameters.

603.19.3.1.6.4.2-Minimum Bending Radius for Corrugated Plastic Duct:  In addition to the component testing stated herein, the manufacturer shall establish, through testing, the minimum bending radius for the duct. The test consists of a modified duct wear test as described in Chapter 4, Article 4.1.7 of FIB Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning”. The test apparatus shall be identical to the wear test apparatus with the same clamping force as a function of the number of strands in the duct; however, modify the procedure as follows: do not move the sample along the strand to simulate wear; the test duration will be 7 days. Upon completion of the test duration, remove the duct. The minimum wall thickness along the strand path must not be less than 0.06 inch for duct up to 3.35 inches diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter.
603.19.3.1.6.4.3-Corrugated Duct Connections and Fittings: Make all splices, joints, couplings and connections to anchorages with devices or methods (i.e. mechanical couplers, plastic sleeves in conjunction with shrink sleeve) producing a smooth interior alignment with no lips or kinks. Design all connections and fittings to be airtight. Duct tape is not permitted to join or repair duct connections. Construct connections and fittings from polyolefin materials containing antioxidant stabilizer(s) meeting the requirements established in Section 603.19.3.1.4 or 603.19.3.1.6.4.

603.19.3.1.6.5-Corrugated Ferrous Metal Duct: Do not use corrugated ferrous metal ducts in any location.

603.19.3.1.6.6-Epoxy Coated Metal Duct: Do not use epoxy coated metal ducts in any location.

603.19.3.1.6.7-Shipping and Storage of Ducts: Furnish ducts with end caps to seal the duct interior from contamination. Ship in bundles which are capped and covered during shipping and storage. Protect ducts against ultraviolet degradation, crushing, excessive bending, dirt contamination and corrosive elements during transportation, storage and handling. Do not remove end caps supplied with the duct until the duct is incorporated into the bridge component. Store ducts in a location that is dry and protected from the sun. Storage must be on a raised platform and completely covered to prevent contamination. If necessary, wash only the outside surface of the duct before use to remove any contamination.

603.19.3.1.7-Internal Duct Mechanical Couplers, O-Ring Assemblies and Heat Shrink Sleeve Requirements:

603.19.3.1.7.1-Mechanical Couplers: Construct mechanical internal duct couplers with stainless steel, plastic or a combination of these materials. Use plastic resins meeting the requirements of Sections 603.19.3.1.4 or 603.19.3.1.6.4 to construct plastic couplers. Use ASTM A240 Type 316L stainless steel to make metallic components.

603.19.3.1.7.2-O-Rings: O-ring duct coupling shall be made from plastic resins meeting the requirements of Section 603.19.3.1.4 or 603.19.3.1.6.4.

All O-ring materials shall conform to the following requirements:

Mechanical Properties
- Shore hardness A (ASTM D2240): 30-40
- Ultimate elongation (ASTM D412) > 300%
- Tension Set @ 100%, 200% & ultimate elongation (ASTM D412) < 5
- Tear Strength Die T, (ASTM D624): 110 pli

Accelerated Testing
- Thermal Deterioration 70 hours @ 125º C (ASTM D573)
- Change in tensile strength < 3%
Change of elongation < 25%
Change of hardness < 5%
Compression Set 22 hours @ 125º C (ASTM D573) < 20%

Environmental Resistance
Ozone Resistance 70 hours @ 40º C & 50 MPa partial ozone pressure (ASTM D1149): No Cracks
Low Temp. @ -20º C (ASTM D746): Not Brittle Pass

**603.19.3.1.7.3-Heat Shrink Sleeves:** Furnish and install heat shrink sleeves having a uni-directional circumferential recovery manufactured specifically for the size of the duct being coupled consisting of an irradiated and linear-density polyethylene for internal applications. Furnish adhesive having the same value to steel polyolefin applications. Ensure the heat shrink sleeves have an adhesive layer that will withstand 150º F operating temperature and meet the requirements of the following table:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Fully Recovered Thickness</td>
<td></td>
<td>92 mils</td>
</tr>
<tr>
<td>Peel Strength</td>
<td>ASTM D 1000</td>
<td>29 pli</td>
</tr>
<tr>
<td>Softening Point</td>
<td>ASTM E 28</td>
<td>162oF</td>
</tr>
<tr>
<td>Lap Shear</td>
<td>DIN 30 672M</td>
<td>87 psi</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>ASTM D 638</td>
<td>2,900 psi</td>
</tr>
<tr>
<td>Hardness</td>
<td>ASTM D 2240</td>
<td>46 Shore D</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>ASTM D 570</td>
<td>Less than 0.05%</td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td>Yellow</td>
</tr>
<tr>
<td>Minimum Recovery</td>
<td>Heat Recovery Test</td>
<td>33%</td>
</tr>
</tbody>
</table>

Install heat shrink sleeves using procedures and methods in accordance with the manufacturer’s recommendations.

**603.19.3.1.8-System Test Requirements:** For each family of post-tensioning systems, assemble systems and perform the pressure test defined herein. For each family of post-tensioning systems, test two assemblies (largest and smallest) from the family. The post-tensioning assembly includes at least one of each component required to make a tendon from grout cap to grout cap.

**603.19.3.1.8.1-Grouting Component Assembly Pressure Test:** Assemble anchorage and grout cap with all required grouting attachments (grout tube, plugs, etc.). Seal the opening in the anchorage where the duct connects. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five (5) minutes with no more than 15 psi reduction in pressure. For systems using the same anchorages, grout caps and grouting attachments as previously approved system, the Grouting Component Assembly Pressure Test may...
include documentation from a previous submittal with written certification that the same components are being utilized in both anchorages.

603.19.3.1.8.2-Internal Duct Systems: Perform a system test for the assembly for compliance with the requirements of Chapter 4, Article 4.2 Stage 1 and Stage 2 Testing contained in FIB Technical Report, Bulletin 7, titled “Corrugated Plastic Duct for Internal Bonded Post-Tensioning.” For bar systems, modify the system test length to 15 feet.

Test the coupler for proper function by casting the coupler into a two part concrete test block using match cast techniques. Use blocks that are 12 inch x 12 inch x 12 inch (300 mm x 300 mm x 300 mm). After the concrete has hardened, pull the blocks apart and clean the surface of any bond breaker materials. Using an external apparatus, clamp the block together and maintain 40 psi pressure on the block cross-section during the pressure test. Do not apply epoxy between the blocks for this portion of the test. Pressurize the duct within the test block to 1.5 psi and lock off the outside air source. The assembly must sustain a 1.5 psi internal pressure for five (5) minutes with no more than 0.15 psi reduction in pressure. Separate the duct coupler blocks from the duct system, remove the clamping device, place a 1/16 inch layer of epoxy on the face of both blocks, and clamp the blocks together and maintain a pressure of 40 psi on the block cross-section for 24 hours. Upon removal of the clamping force, demolish the blocks. The coupler and attached ducts should be intact and free of epoxy, and properly attached without crushing, tearing or other signs of failure. This test will not be required if the Engineer approves prior test results performed for the same system submitted by the Contractor.

The grout cap to anchorage seal and the duct to pipe assembly must comply with the following test. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. The length of the test pipe assembly for this test is 15 feet.

Acceptance of the “duct system test data” will be a prerequisite for shop drawing submission of the duct system.

603.19.4-Grout:
A. Grouts shall be prebagged in plastic lined or coated bags. Stamp grout bags with date of manufacture, lot number, shelf life, and mixing instructions. Any change of materials or material sources requires retesting and certification of the conformance of the grout with the physical properties requirements. A copy of the Quality Control Data Sheet for each lot number and shipment sent to the job site shall be provided to the Contractor by the grout supplier and furnished to the Engineer.
B. Materials with a total time from manufacture to usage in excess of six months shall be retested and certified by the supplier before use or shall be removed and replaced.
C. Manufacturers of post-tensioning grout seeking evaluation of their product shall submit material to the WVDOT Materials Laboratory for testing and shall provide certified test reports from an audited and independent Cement and Concrete Reference Laboratory (CCRL), which shows the material meets all the requirements specified herein.
D. Grout shall be stored in a location that is waterproof and convenient to the work. Storage in the open must be on a raised platform and with an adequate waterproofing. On-site storage of grout is limited to a maximum period of one month.

E. The grout material shall be mixed in accordance with the manufacturer’s recommendations.

F. Grouts shall achieve a non-bleeding characteristic and shall maintain grout fluidity in strict compliance with the manufacturer’s recommendations.

G. Grouts shall contain no aluminum powder.

H. The water content shall be the minimum necessary for proper placement, and shall not exceed a water-cement ratio of 0.45.

I. Grouts and temporary corrosion protection methods shall not involve toxic substance.

J. Grout shall meet or exceed the specified physical properties stated herein as determined by the following standard and modified ASTM test methods.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Value</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Chloride Ions</td>
<td>Max. 0.08% by weight of cementitious material</td>
<td>ASTM C 1152</td>
</tr>
<tr>
<td>Hardened Height Change @ 24 hours and 28 days</td>
<td>0.0% to + 0.2%</td>
<td>ASTM C 1090*</td>
</tr>
<tr>
<td>Fine Aggregate (if utilized)</td>
<td>99 percent passing No. 50 Sieve (300 micron)</td>
<td>ASTM C 136**</td>
</tr>
<tr>
<td>Wet Density – Laboratory</td>
<td>Report maximum and minimum obtained test value lb/ft³ (kg/l)</td>
<td>ASTM C 185</td>
</tr>
<tr>
<td>Wet Density – Field</td>
<td>Report maximum and minimum obtained test value lb/ft³ (kg/l)</td>
<td>ASTM C 138</td>
</tr>
<tr>
<td>Compressive Strength @ 28 days (Average of 3 cubes)</td>
<td>&gt;= 6,000 psi (41.5 MPa)</td>
<td>ASTM C 942</td>
</tr>
<tr>
<td>Initial Set of Grout</td>
<td>Min. 3 hours, Max. 12 hours</td>
<td>ASTM C 953</td>
</tr>
<tr>
<td>Fluidity Test *** Efflux Time from Flow Cone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Immediately after mixing</td>
<td>Min. 20 sec., Max. 30 sec.</td>
<td>ASTM C 939</td>
</tr>
<tr>
<td>Or</td>
<td>Min. 9 sec., Max. 20 sec.</td>
<td>ASTM C 939 **</td>
</tr>
<tr>
<td>(b) 30 minutes after mixing with remixing for 30 sec.</td>
<td>Max. 30 sec.</td>
<td>ASTM C 939</td>
</tr>
<tr>
<td>Bleeding @ 3 hours</td>
<td>Max. 0%</td>
<td>ASTM C 940 ****</td>
</tr>
<tr>
<td></td>
<td>Max. 4% at 20.3 psi (140 kPa) for Vertical Rise 0 ft. (0 m) $\leq$ x $\leq$ 2 ft. (0.6 m)</td>
<td>Schupack *****</td>
</tr>
<tr>
<td></td>
<td>Max. 2% at 31.9 psi (220 kPa) for Vertical Rise 2 ft. (0.6 m) $\leq$ x $\leq$ 6 ft. (1.8 m)</td>
<td>Schupack *****</td>
</tr>
</tbody>
</table>
Max. 0% at 52.2 psi (360 kPa) for Vertical Rise 6 ft. (1.8 m) < x < 100 ft (30 m)  Schupack

| Permeability @ 28 days | Max. 2500 coulombs at 30 V for 6 hours | ASTM C 1202 |

* Modify ASTM C 1090 to include verification at both 24 hours and 28 days.
** Use ASTM C117 procedure modified to use #50 sieve. Determine the percent passing the #50 sieve after washing the sieve.
*** Adjustments to flow rates will be achieved by strict compliance with the manufacturer’s recommendations. The time efflux is the time to fill a one liter container placed directly under the flow cone.
**** Modify the ASTM C 939 test by filling the cone to the top instead of the standard level. The efflux time is the time to fill a one quart (one liter) container placed directly under the flow cone.
***** Modify ASTM C 940 to conform with the wick induced bleed test as follows:
   (a) Condition dry ingredients, mixing water, prestressing strand and test apparatus overnight at 65 to 75°F (18 to 24°C).
   (b) Insert 0.21 gal (800 ml) of mixed conditioned grout with conditioned water into the 0.26 gal (1,000 ml) graduated cylinder. Mark the level of the top of the grout.
   (c) Wrap the strand with 2 inch (50.8 mm) wide duct or electrical tape at each end prior to cutting to avoid splaying of the wires when it is cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before temperature conditioning. Insert completely a 20 inch (508 mm) length of conditioned, cleaned, AASHTO M203, Grade 270 (1860 MPa), seven wire strand (0.6 inch (13 mm) diameter) into the 0.26 gal (1,000 ml) graduated cylinder (possibly using a centralizer). Mark the level of the top of the grout.
   (d) Store the mixed grout at the temperature range listed above in (a).
   (e) Measure the level of the bleed water every 15 minutes for the first hour and hourly afterward for three hours.
   (f) Calculate the bleed water, if any, at the end of the three hour test period and the resulting expansion per the procedures outlined in ASTM C 940, with the quantity of bleed water expressed as a percent of the initial grout volume. Note if the bleed water remains above or below the top of the grout.

****** Schupack Pressure Bleed Test Using the Gelman Filtration Funnel
   (a) Grouts shall be mixed in accordance with the manufacturer’s instructions, and as approved by the engineer.
   (b) Fill the filtration funnel with 0.053 gal (200 ml) of freshly mixed grout and screw cap on hand tight, while keeping funnel in upright position.
   (c) Place funnel in frame.
   (d) Connect air supply (air pressure at 0 psi (0 kpa)).
   (e) Allow grout to rest in funnel for 10 minutes.
   (f) Increase pressure to specified test pressure from table above.
   (g) Hold at specified pressure for 5 minutes and record bleed volume to the nearest 0.00005 gal (0.2 ml) at the end of hold time.
   (h) Bleed volume shall be reported as a percentage of the sample volume.
      \[
      \%\text{ bleed} = \frac{\text{bleed (gal)}\times 100}{0.053\text{ gal}}
      \]
      If a loss of pressure occurs prior to completion of step (h), the test is considered to have failed for the given pressure level.

603.19.5-Samples for Testing and Identification:

603.19.5.1-General: Testing shall conform to the applicable AASHTO/ASTM Specifications for the prestressing material used. All material samples for testing shall be
furnished by the Contractor at no cost to the Division. Consider job site or site referred to herein as the location where the prestressing steel is to be installed.

**603.19.5.2-Testing of Prestressing Steel:** Furnish samples for testing as described below for each manufacturer of prestressing strand or bar to be used on the project.

With each sample of prestressing steel strand or bar furnished for testing, submit a certification stating the manufacturer’s minimum guaranteed ultimate tensile strength of the sample furnished.

The Engineer will sample the following materials, at the plant, from the prestressing steel used for post-tensioning operations:

(a) For strand: three randomly selected samples, 5 feet long, per manufacturer, per size of strand, per shipment, with minimum of one sample for every ten reels delivered.

(b) For bars: three randomly selected samples, 5 feet long, per manufacturer, per size of bar, per heat of steel, with minimum of one sample per shipment.

One of each of the samples furnished to represent a lot, will be tested. The remaining sample(s), properly identified and tagged, will be stored by the Engineer for future testing. In the event of loss or failure of the component, the stored sample will be utilized to evaluate for minimum strength requirements. For acceptance of the lot represented, test results must show 100% of guaranteed ultimate tensile strength (GUTS).

**603.19.5.3-Lots and Identification:** A lot is that parcel of components as described herein. All bars, of each size from each mill heat of steel, and all strand from each manufactured reel to be shipped to the site, must be assigned an individual lot number and must be tagged in such a manner that each such lot can be accurately identified at the job site. Submit records to the Engineer identifying assigned lot numbers with the heat or reel of material represented. All unidentified prestressing steel, or bars received at the site will be rejected. In addition, loss of positive identification of these items at any time will be cause for rejection.

**603.19.5.4-Testing of Grout:** The Contractor shall provide the current certified mill test reports for each lot of grout received from the manufacturer showing compliance with the requirements in Section 603.19.4. Any change of materials or material sources requires retesting and certification of the conformance of the grout with the physical properties requirements. A copy of the Quality Control Data Sheet for each lot number and shipment sent to the job site shall be provided to the Contractor by the grout supplier and furnished to the Engineer.

Materials with a total time from manufacture to usage in excess of either six months, or the stated shelf-life, shall be re-tested and certified by the supplier before use, or shall be removed and replaced. Materials stored at the job site more than one month will be rejected and the Contractor shall remove them from the job site.

**603.19.5.5-Approval of Materials:** The approval of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

**603.19.6-Testing by the Contractor:**
603.19.6.1-Tendon Modulus of Elasticity Test: For this project, the Contractor shall perform a tendon modulus of elasticity test in accordance with the following procedure.

For the purpose of accurately determining the tendon elongations while stressing, bench test two (2) samples of each size of tendon to determine the modulus of elasticity prior to stressing the initial tendon.

For the purpose of this test, the bench length between anchorages must be at least 40 feet and the tendon duct at least 2 inches clear of the tendon all around. The test procedure must consist of stressing the tendon at the anchor assembly with a load cell at the dead end. Tension the test specimen to 80% of ultimate in ten equal increments and the detension from 80% of ultimate to zero in ten equal decrements. For each increment and decrement, record the gauge pressure, elongation and load cell force. Note elongations of the tendon for both ends and the central 30 feet, measured to accuracy of ± 1/32 inch. Correct the elongations for the actual anchorage set of the dead end.

Calculate the modulus as follows:

\[ E = \frac{PL}{Adl} \]

Where:

- \( P \) = force in tendon
- \( L \) = distance between pulling wedges and dead wedges or exact length in center 30 feet of the tendon.
- \( A \) = cross sectional area of the tendon based on nominal area.
- \( dl \) = strand elongation for load \( P \).

If the bench test result varies from the modulus of elasticity used for shop drawings by more than 1%, submit revisions to the theoretical elongations to the Engineer for approval.

When the observed elongations of the tendon in the erected structure fall outside the acceptable tolerances, or to otherwise settle disputes, additional Tendon Modulus of Elasticity Tests may be required to the satisfaction of the Engineer.

If the source of the prestressing steel changes during the course of the project, additional test series or substantiations from previous projects, not to exceed two per source, will be required.

The apparatus and methods used to perform the test must be submitted to the Engineer for approval. Test must be conducted in the Engineer’s presence.

603.19.6.2-In-Place Friction Test: This test is intended to demonstrate that the friction characteristics, losses, and resulting tendon forces are in agreement with the design assumptions. This test is only required if authorized by the Engineer in order to resolve discrepancies between actual and theoretical elongations in excess of ± 5% percent.

The test procedure shall consist of stressing the tendon at an anchor assembly with a load cell at the dead end. The test specimen shall be tensioned to 80 percent of ultimate tendon tensile strength in eight equal increments and de-tensioned in eight equal decrements. For each increment and decrement, the gauge pressure, elongations, and load cell force shall be recorded. Account shall be taken of any wedge seating in both the live end (i.e., back of jack) and the dead end (i.e., back of load cell) and of any friction within the anchorages, wedge plates, and jack as a result of slight deviations of the strands through these assemblies. For long tendons requiring multiple jack pulls with intermediate
temporary anchoring, care shall be taken to keep an accurate account of the elongation at
the jacking end allowing for intermediate wedge seating and slip of the jack’s wedges.

When friction is to be reduced, only graphite is to be used as a lubricant subject to the
approval of the Engineer. The ducts shall be blown dry with oil free air to remove any
excess graphite.

If the elongation falls outside the ± 5% range compared to the anticipated elongations,
investigate the reason and make detailed calculations confirming the final tendon forces
are in agreement with the approved Plans.

Significant shortfall in elongations is indicative of poor duct alignments and/or
obstructions. Correct or compensate for such elongations in a manner proposed by the
Contractor and reviewed and approved by the Engineer at no additional cost to the
Department.

If, for the Contractor's expected friction coefficients, the elongations fall outside the
plus or minus 5 percent range, the Contractor shall investigate the reason and make
revisions to his post-tensioning operations such that the final tendon forces are in
agreement with the Plans.

The apparatus and methods used to perform the test must be submitted to the Engineer
for approval. Tests must be conducted in the Engineer’s presence.

603.19.6.3-Grout Fluidity: Contractor shall perform a grout fluidity test in
accordance with Section 603.19.4, prior to the beginning of the injection process and after
grouting each tendon. The test shall be performed on a sample taken from the end of the
pump hose before grouting and at the outlet end of the tendon after the tendon has been
properly grouted. The testing shall be repeated for each two hours of grouting operations.
The efflux time shall be within 5 seconds of the values established during laboratory
testing.

603.19.6.4-Tests Reports Required: Submit two copies of the “Tendon Modulus of
Elasticity Test” reports to the Engineer at least 30 days prior to installing the tendons.
Submit two copies of the “In Place Friction Test” reports to the Engineer within two
(2) weeks after successful installation of the tested tendon.
Two copies of the grout fluidity test per tendon shall be submitted to the Engineer
within three days after performing the test.

603.19.6.5-Payment for Testing: Testing by the Contractor will not be paid for
separately but shall be incidental to the price paid for the post-tensioning.

603.19.6.6-Application of Test Results: Re-evaluate the theoretical elongation shown
on the post-tensioning shop drawing or working drawings using the results for the Tendon
Modulus of Elasticity Test and In Place Friction Test as appropriate and correct as
necessary. Submit revisions to the theoretical elongations to the Engineer for approval.
No work shall proceed on grouting the tendons until the Engineer has reviewed and
approved the revisions to the theoretical elongations.

603.19.7-Protection of Prestressing Steel:
603.19.7.1-Shipping, Handling, and Storage: Protect all prestressing steel against
physical damage and corrosion at all times, from manufacture to final grouting or encasing
in the concrete. The Engineer will reject prestressing steel that has sustained physical damage. Carefully inspect any reel that is found to contain broken wires during use. Remove and discard lengths of strand containing broken wires. The wire must be bright and uniformly colored when installed, having no foreign matter or pitting on its surface.

Prestressing steel shall be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents rust or other results of corrosion, shall be placed in the package or form, or shall be incorporated in a corrosion inhibitor carrier type packaging material, or when permitted by the Engineer, may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel, concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specification MIL-P-3420. Packaging or forms damaged by any cause shall be immediately replaced or restored to the original condition.

The shipping package or form shall be clearly marked with a statement that the package contains high-strength prestressing steel, the care to be used in handling, and the type, kind, and amount of corrosion inhibitor used, including the date when placed, safety orders, and instructions for use. Low relaxation (stabilized) strand shall be specifically designated per requirements of AASHTO M203. All such strand not so designated shall be rejected.

603.19.7.2-During Installation in the Structure: The time between the first installation of the post-tensioning steel in the duct and the completion of the stressing and grouting operations shall not exceed twenty (20) calendar days unless the use of a corrosion inhibitor is approved by the Engineer. The corrosion inhibitor shall not reduce the bond between the post-tensioning steel and the grout or the ducts, and the removal of the corrosion inhibitor shall not introduce remnant moisture into the ducts or annular spaces between the wires of the post-tensioning strand. Any light surface corrosion forming during this period will not be cause for rejection of the post-tensioning steel. These twenty calendar days shall also apply to the post-tensioning steel used for the In-Place Friction Test, if it is to be used as a production tendon.

Flushing of grout is not permitted and vacuum grouting is required to repair all voids as defined in Section 603.19.12.6.7. Flushing of ducts is only permitted as defined in Section 603.19.10. When flushing is permitted, use flush water containing slack lime (calcium hydroxide) or quicklime (calcium oxide) in the amount of 0.17 lb/gal.

Except when approved by the Engineer in writing, failure to grout tendons within sixty (60) calendar days will result in stoppage of the affected work.

603.19.8-Fabrication of Post-Tensioning Ducts and Anchorages in the Final Structure:

603.19.8.1-General: Accurately and securely fasten all post-tensioning anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedded items at the locations shown on the plans or on the approved Shop or Working Drawings or as otherwise approved by the Engineer. Construct tendons using the minimum number of duct splices possible.

603.19.8.2-Ducts: Accurately align and position ducts at the locations shown on the Plans, according to the approved Shop or Working Drawings, or as otherwise approved by
the Engineer. Securely fasten all internal ducts in position at regular intervals not exceeding two feet (0.6 meter) for round plastic ducts, and one foot (0.3 meter) for flat ducts to prevent movement, displacement, or damage from concrete placement and consolidation operations. Show the method and spacing of duct supports on appropriate Shop Drawings.

Ensure all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks, or dents.

Carefully check all ducts and repair as necessary before the placing of any concrete commences. The tolerance on the location of the ducts for the tendons shall be as specified below in Section 603.19.8.5.

After installing the ducts and until grouting is complete, ensure that all ends of ducts, connections to anchorages, splices, inlets and outlets are sealed at all times. Provide an absolute seal of anchorage and duct termination locations by using plumber’s plugs or equal. Grout inlets and outlets will be installed with plugs or valves in the closed position. Leave low point outlets open. The use of duct tape is not permitted.

**603.19.8.3-Splices and Joints:** All splices, joint couplings, and connections (inlet and outlet) and valves shall be part of the approved post-tensioning system. Approved shrink sleeve material may be used to repair duct. The use of any tape to repair or seal the duct is not permitted.

**603.19.8.4-Location of Grout Inlets and Outlets:** Place grout inlets and outlets at locations as shown on the plans or approved shop drawings. Equip all grout inlets and outlets with positive shut-off devices. At a minimum, grout inlets and outlets will be placed in the following positions:

(a) Top of the tendon anchorage,
(b) Top of the grout cap,
(c) At the high points of the duct when the vertical distance between the highest and lowest point is more than 20 inches;
(d) At a location 3 feet past high points of the duct on the down stream side opposite the direction of grouting,
(e) At all low-points,
(f) At major changes in the cross section of the duct,
(g) At intermediate point(s) for tendons longer than 150 feet,
(h) At other locations required by the Engineer.

Extend grout tubes a sufficient distance out of the concrete member to allow for proper closing of the valves.

All grout caps used must be installed to prevent entrapment of air or water voids and must provide 100 percent coverage of all tendons, wedges and wedge plates in the anchorage.

**603.19.8.5-Tolerances:** Position post-tensioning ducts within the tolerances given below:

<table>
<thead>
<tr>
<th>Tolerances in Inches For:</th>
<th>Vertical</th>
<th>Lateral</th>
</tr>
</thead>
</table>

Page 20 of 33
Position

<table>
<thead>
<tr>
<th>Transverse Deck Tendons in Slab</th>
<th>± ¼</th>
<th>± ½</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal Tendons</td>
<td>± ¼</td>
<td>± ½</td>
</tr>
<tr>
<td>All Other Cases or in Cases of Doubt</td>
<td>± ¼</td>
<td>± ¼</td>
</tr>
</tbody>
</table>

In all other cases, ensure that tendons are not out of position by more than ± 1/4 inch in any direction.

Ensure entrance and exit angles of tendon paths at anchorages and/or at faces of concrete are within ± 3 degrees [± 5%] of desired angle measured in any direction and any deviations in the alignment are accomplished with smooth transitions without any kinks.

Angle changes at duct joints must not be greater than ± 3 degrees [± 5%] in any direction and must be accomplished with smooth transitions without any kinks.

Locate anchorages within ± 1/4 inch of desired position laterally and ± 1 inch along the tendon except that minimum cover requirements must be maintained.

Position anchorage confinement reinforcement in the form of spirals, multiple U shaped bars or links, properly centered around the duct and start within 1/2 inch of the back of the main anchor plate.

If conflicts exist between the reinforcement and post-tensioning duct, the position of the post-tensioning duct shall prevail and the reinforcement shall be adjusted locally with the Engineer’s approval.

603.19.8.6-Internal Duct Pressure Test: Pressure test all internal ducts, before casting concrete. Seal the tendon at the anchorage duct at the termini and test with compressed air to determine if the duct connections require repair. In the presence of the Engineer, pressurize the duct to 1.5 psi and lock-off the outside air source. Record the pressure loss over one (1) minute. If the pressure loss exceeds 0.15 psi, repair the leaks in the duct using methods approved by the Engineer. Upon completion of repairs approved by the engineer, the duct shall be retested to the requirements specified above.

603.19.8.7-Post-Tensioning System Field Certification: Post-Tensioning System supplier shall furnish the engineer with a certification that the post-tensioning system chosen for this project has been installed without modification as indicated in the approved shop drawings.

603.19.9 Placing Concrete

603.19.9.1-Precautions: The Contractor shall exercise great care when placing and consolidating concrete so as not to displace or damage any of the post-tensioning ducts, anchorage assemblies, splices and connections, reinforcement, or other embedments. Fabricate all duct splices to prevent duct kinks during concrete placement. Use mandrels at joints as needed to maintain duct alignment and shape.

The Contractor shall ensure that ducts located within mass concrete pours have the capacity to withstand the concrete temperature expected according to the thermal control plan as per Section 601.12.4.1 of the Special Provisions. For mass concrete pours, the contractor may propose to use galvanize rigid steel pipe ducts for Engineer’s approval, at no additional cost to the Division.
603.19.9.2-Proving of Post-Tensioning Ducts: Upon completion of concrete placement, prove that the post-tensioning ducts are free and clear of any obstructions or damage and are able to accept the intended post-tensioning tendons by passing a torpedo through the new joints in the ducts. Use a torpedo having the same cross-sectional shape as the duct and that is a 1/4 inch smaller all around than the clear, nominal inside dimensions of the duct. Make no deductions to the torpedo section dimensions for tolerances allowed in the manufacture or fixing of the ducts. For straight ducts, use a torpedo at least 2 feet long. For curved ducts, determine the length so that when both ends touch the outermost wall of the duct, the torpedo is 1/4 inch clear of the innermost wall. If the torpedo will not travel completely through the duct, the Engineer will reject the member, unless a workable repair can be made to clear the duct. The torpedo must pass through the duct easily, by hand, without resorting to excessive effort or mechanical assistance.

603.19.9.3-Problems and Remedies: The Engineer will reject ducts or any part of the work found to be deficient. Perform no remedial or repair work without the Engineer’s approval. Any remedial work will be completed at no additional cost to the Division.

603.19.10-Installing Tendons: For tendons subjected to contamination with chlorides, flush the duct before placing the prestressing strands, with lime treated potable water and test for presence of chlorides and oils. Chlorides in the water must be less than 600 ppm. If chloride levels are in excess of 600 ppm, continue to flush the duct until the chloride level is below 250 ppm. Blow oil-free compressed air through the duct to remove any excess water in the duct.

Post-tensioning strands may be pushed or pulled through the ducts to make up a tendon using methods which will not snag on any lips or joints or damage the duct. Strands which are pushed shall be rounded off at the end of the strand or fitted with a smooth protective cap. During the installation of the post-tensioning strand in to the duct, the strand shall not be intentionally rotated by any mechanical device.

Alternatively, strands may be assembled into the tendon, which then may be pulled through the duct together using a special steel wire sock (“Chinese finger”) or other device attached to the end. If the ends of the strands are welded or brazed, they shall be cut back 18 inches from the weld or braze. Round the end of the pre-assembled tendon for smooth passage through the duct. Cutting shall be done with an abrasive saw or equal. Flame cutting shall not be allowed.

In accordance with this Special Provision, the time requirements for corrosion protection shall commence from the time the strands were first placed in the ducts and not from the time of concrete placement. Do not install permanent tendons before the completion of testing as required by this Special Provision and plans. As a sole exception, the tendon to be tested in the “In Place Friction Test” may be installed for the test.

603.19.11-Post-Tensioning Operations:

603.19.11.1-General: Do not apply post-tensioning forces unless the concrete has attained the specified compressive strength as determined by cylinder tests. The stressing of post-tensioning tendons shall be under the immediate supervision of the qualified project personnel as described in Section 603.19.1.7. In addition, a qualified representative of the post-tensioning Specialty Contractor, who shall exercise rigid control of the operations as necessary for full compliance with all requirements stated in this Section (603.19.11) shall
be present. As a minimum, the representative shall be present at the beginning of each different type of post-tensioning operation. If the representative determines that the Contractor’s crew is thoroughly familiar with one type of operation, he shall deliver a signed statement of competence for the crew to the Engineer for review. Upon approval by the Engineer of the statement of competence, the presence of the representative shall not be required again until a different type of post-tensioning operation occurs. The statement shall list the names of the Contractor’s crew and crew leader who will be responsible for the post-tensioning operations. The stressing operations shall be overseen by the Contractor’s crew leader who shall demonstrate competence in supervising the stressing operations and performing elongation measurements and calculations; this crew leader shall preferably be an Engineer. No stressing operations shall be performed without direct supervision of the representative or the Contractor’s approved project personnel.

603.19.11.2-Stressing Tendons: All post-tensioning steel shall be tensioned by means of hydraulic jacks so that the post-tensioning force shall not be less than that required by the Plans, or by approved Shop Drawings, or as otherwise required or approved by the Engineer. Do not utilize monostrand jacks to stress tendons with five or more strands. Monostrand jacks will be allowed for stressing tendons only when specifically approved by the Engineer, or when strand tendons are housed in flat ducts that preclude intertwining of strands. Monostrand jacking is permitted provided the elongation of individual strands is kept within a tolerance of +10% of the calculated value. In addition, the average elongation of the group of strands in the duct shall be within \( \pm 5\% \) of the calculated elongation.

The maximum temporary stress (jacking stress) in the post-tensioning steel shall not exceed 80 percent of its specified minimum ultimate tensile strength. Tendons shall not be overstressed to achieve the expected elongation.

The post-tensioning steel shall be anchored at initial stresses that will result in the long term retention of permanent stresses or forces of not less than those shown on the Plans or the approved Shop Drawings. Unless otherwise approved by the Engineer, the initial stress after anchor set shall not exceed 70 percent of the specified ultimate tensile strength of the post-tensioning steel.

Permanent stress and permanent force are the stress and force remaining in the post-tensioning steel after all losses, including long term creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in the post-tensioning steel from the sequence of stressing, friction and unintentional wobble of the ducts, anchor set, friction in the anchorages, and all other losses peculiar to the post-tensioning system.

603.19.11.3-Stressing Sequence: The Contractor shall follow the sequence, the phase and the end from which tendons must be stressed shown in the plans or required by the Engineer. The Contractor shall not modify the stressing sequence shown on the Plans or the approved Construction Manual without approval from the Engineer.

603.19.11.4-Stressing Equipment: Only use equipment furnished by the supplier of the post-tensioning system (tendons, hardware, anchorages, etc.).
603.19.11.4.1-Stressing Jacks and Gauges: Each jack must be equipped with a pressure gauge for determining the jacking pressure. The pressure gauge must have an accurate reading gage with a dial at least 6 inches in diameter.

603.19.11.4.2-Calibration of Jacks and Gauges: Calibrate each jack and its gauge(s) as a unit. The calibration must consist of three test cycles with the cylinder extension of the jack in various positions (i.e. 2-inch, 4 inch, 8 inch stroke). At each pressure increment, average the forces from each test cycle to obtain an average force. Perform the calibration with the equipment (jack, pump, hoses, etc.) setup in the same configuration that is intended to be used at the job site. The post-tensioning supplier or an independent laboratory shall perform initial calibration of jacks and gauge(s). Use load cells calibrated within the past 12 months to calibrate stressing equipment. For each jack and gauge unit used on the project, furnish certified calibration charts and curves to the Engineer prior to stressing. Supply documentation denoting the load cell(s) calibration date and tracability to NIST (National Institute of Standards and Technology) along with the jack/gauge calibration.

Provide the Engineer with certified calibration charts and curves prior to the start of the work and every six months thereafter, or as requested by the Engineer. Calibrations subsequent to the initial calibration with a load cell may be accomplished by the use of a master gauge. Supply the master gauge to the Engineer in a protective waterproof container capable of protecting the calibration of the master gauge during shipment to a laboratory. Provide a quick-attach hydraulic manifold to enable quick and easy installation of the master gauge to verify the permanent gauge readings. The master gauge will be calibrated and provided to the Engineer. The master gauge will remain in the possession of the Engineer for the duration of the project.

Any jack repair, such as replacing seals or changing the length of the hydraulic lines, is cause for recalibration using a load cell.

No extra compensation will be allowed for the initial or subsequent calibrations or for the use and required calibrations of the master gauge.

603.19.11.5-Elongations and Agreement with Forces: Ensure that the forces being applied to the tendon and the elongation of the post-tensioning tendon can be measured at all times.

Measure tendon elongations to the nearest 1/16 inch.

For the required tendon force, the observed elongation must agree within 5% of the theoretical elongation or the entire operation must be checked and the source of error determined and remedied to the satisfaction of the Engineer before proceeding further. Do not overstress the tendon to achieve the theoretical elongation.

In the event that agreement between the observed and theoretical elongations at the required force falls outside the acceptable tolerances, the Engineer may, at his discretion and without additional compensation to the Contractor, require additional tests for “In-Place Friction” in accordance with Section 603.19.6.2.

603.19.11.6-Friction: The Contract Plans were prepared based on the assumed friction and wobble coefficients and anchor set noted on the Plans. The Contractor shall submit calculations and show a typical tendon force diagram, after friction, wobble, and anchor set losses on the Shop Drawings based upon the expected actual coefficients and values for
the post-tensioning system to be used. These coefficients and values shall be given on the Shop Drawings.

If, in the opinion of the Engineer, the actual friction significantly varies from the expected friction, the Contractor shall revise his post-tensioning operation such that the final tendon force is in agreement with the Plans.

When friction is to be reduced, only graphite is to be used as a lubricant subject to the approval of the Engineer. The ducts shall be blown dry with oil free air to remove any excess graphite.

**603.19.11.7-Wire Failures in Post-Tensioning Tendons:** Multi-strand post-tensioning tendons having wires, which failed by breaking or slippage during stressing, may be accepted provided the following conditions are met:

(a) The completed structure shall have a final post-tensioning force of at least 98 percent of the design total post-tensioning force.

(b) Any single tendon shall have no more than a five percent reduction in cross-sectional area of post-tensioning steel due to wire failure.

As an exception, any of the above conditions may be waived as approved by the Engineer when conditions permit the Contractor to propose acceptable alternative means of restoring the post-tensioning force lost due to wire failure.

**603.19.11.8 Cutting of Post-Tensioning Steel:** Post-tensioning steel shall be cut by an abrasive saw within ¾ to 1½ inches away from the anchoring device. Flame cutting of post-tensioning steel is not allowed.

**603.19.11.9-Record of Stressing Operations:** The Contractor shall keep a record of the following post-tensioning operations for each tendon installed:

(a) Project name, number.

(b) Contractor and/or subcontractor.

(c) Tendon location, size, and type.

(d) Date tendon was first installed in ducts.

(e) Reel number for strands and heat number for bars.

(f) Nominal and minimum cross-sectional area.

(g) Assumed Modulus of elasticity.

(h) Date Stressed.

(i) Jack and Gauge serial numbers per stressing operation.

(j) Required jacking force.

(k) Gauge pressures.

(l) Elongations (anticipated and actual).

(m) Anchor sets (anticipated and actual).

(n) Stressing sequence.

(o) Stressing mode (one end/ two ends/ simultaneous).

(p) Witnesses to stressing operation (Contractor and inspector).

(q) Date grouted, days from stressing to grouting, grouting pressure applied, and injection end.
Any other relevant information, including but not limited to the application of approved corrosion inhibitors onto the tendon, shall also be recorded. The Contractor shall provide the Engineer with a complete copy of all stressing and grouting operations.

603.19.11.10-Duct Pressure Field Test: After stressing and before grouting internal tendons, install all grout caps, inlets and outlets and test the tendon with compressed air to determine if duct connections require repair. In the presence of the Engineer, pressurize the tendon to 50 psi and lock-off the outside air source. Record the pressure loss for one minute. A pressure loss of 25 psi is acceptable. If the pressure loss exceeds 25 psi, repair leaking connections using methods approved by the Engineer. Upon completion of repairs approved by the engineer, retest the duct to the requirements specified above.

603.19.11.11-Tendon Protection: Within four hours after stressing, the ends of the tendon shall be cut and the tendon shall be protected against corrosion or harmful effects of debris by temporarily plugging or sealing all openings and vents until the tendon is grouted. Grout caps shall be placed over the tendon end and anchorage plate. If tendon contamination occurs, remove and replace the tendon.

603.19.12-Grouting Operations:

603.19.12.1-General: Prior to grouting, clean ducts with oil-free compressed air to remove water that may interfere with the grout injection. The flushing of ducts with water during grouting operation will not be permitted. Check all inlets and outlets to ensure they are capable of accepting injection of the grout by blowing through the system and proving that each inlet and outlet is free and capable of accepting the grout.

Either install an approved corrosion inhibitor or grout ducts within twenty (20) calendar days from the date of the post-tensioning steel installation except when the Engineer approves in writing.

Grouting operations shall be supervised and conducted by qualified crew members, technician(s) and/or engineer(s) in accordance with Section 603.19.1.7, Project Personnel Qualifications.

Grouting shall be injected from the lowest point on the tendon profile. The location of all grout injection locations must clearly be shown on the Shop Drawings.

603.19.12.2-Grouting Operations Plan: Submit a grouting operations plan for approval at least thirty (30) working days in advance of any scheduled grouting operations. Written approval of the grouting operations plan by the Engineer is required prior to commencement of grouting of the permanent structure. At a minimum, the plan will address and provide procedures for the following items:

1. Names and proof of experience and training for the grouting crew and the crew supervisor in conformance with Section 603.19.1.7 of this Special Provision;
2. Type, quantity, and brand of materials used in grouting including all certifications required;
3. Type of equipment furnished, including capacity in relation to demand and working condition, as well as back-up equipment and spare parts;
4. General grouting procedure;
5. Duct pressure test and repair procedures;
6. Proposed method to control the rate of flow within ducts;
7. Theoretical grout volume calculations;
8. Mixing and pumping procedures;
9. Direction of grouting;
10. Sequence of use of the inlets and outlet pipes;
11. Procedures for handling blockages;
13. The Contractor shall provide additional temporary corrosion protection measures to be used when tendons are left ungrouted for more than twenty (20) calendar days, including methods by which to expel moisture or to remove any contamination if induced as a part of the corrosion protective measures.

A joint meeting of the Contractor, grouting crew and the Engineer will be required five (5) working days prior to the commencement of grouting operations. At the meeting the grouting operation plan, required testing, corrective procedures and any other relevant issues shall be discussed.

603.19.12.3-Grout Inlets and Outlets: Ensure the connections from the grout pump hose to inlets are free of dirt and are airtight. Inspect valves to be sure that they can be opened and closed properly.

603.19.12.4-Supplies: Before grouting operations start, provide an adequate supply of water and compressed air for clearing and testing the ducts, mixing and pumping the grout. Where public water supply is not available, provide a water storage tank of sufficient capacity.

603.19.12.5-Equipment:

603.19.12.5.1-General: Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (holding reservoir) and a pump with all the necessary connecting hoses, valves, and pressure gauge. Provide pumping equipment with sufficient capacity to ensure that the post-tensioning ducts to be grouted can be filled and vented without interruption at the required rate of injection in not more than 30 minutes. Any material not placed within 30 minutes shall be retested for conformance with Section 603.19.4. Grout failing to meet these requirements shall be rejected.

Provide an air compressor and hoses with sufficient output to perform the required functions.

Provide vacuum grouting equipment (volumetric measuring type) prior to the start of grouting operations and retain the equipment on the job during the duration of tendon grouting operations.
603.19.12.5.2-Mixer, Storage Hopper: Provide a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and undispersed cement. The colloidal grout machinery will have a charging tank for blending and a holding tank. The blending tank must be equipped with a high shear colloidal mixer. The holding tank must be kept agitated and at least partially full at all times during the pumping operation to prevent air from being drawn into the post-tensioning duct.

Add water during the initial mixing by use of a flow meter or calibrated water reservoir with a measuring accuracy equal to one percent of the total water volume.

603.19.12.5.3-Grout Pumping Equipment: Provide pumping equipment capable of continuous operation which will include a system for circulating the grout when actual grouting is not in progress.

The equipment shall be capable of maintaining pressure when ducts are completely grouted and have a valve that can be closed off without loss of pressure in the duct.

Grout pumps shall be positive displacement type, capable of providing a continuous grout flow and maintaining a discharge pressure of at least 145 psi.

Pumps shall be constructed to have seals adequate to prevent oil, air or other foreign substances from entering the grout and to prevent loss of grout or water. The capacity will be such that an optimal rate of grouting can be achieved.

A pressure gauge having a full scale reading of no more than 300 psi will be placed at the duct inlet. If long hoses (in excess of 100 ft) are used, place two gauges, one at the pump and one at the inlet. The diameter and rated pressure capacity of the grout hoses must be compatible with the pump output.

603.19.12.5.4-Vacuum Grouting Equipment: Provide vacuum grouting equipment for backup at the job site, concurrently with all pressure grouting operations, consisting of the following:

(a) Volumeter for the measurement of void volume.
(b) Vacuum pump with a minimum capacity of 10 cfm (0.283 cmm) and equipped with flow-meter capable of measuring amount of grout being injected.
(c) Manual colloidal mixers and/or dissolvers (manual high speed shear mixers), for voids less than 20 liters in volume.
(d) Standard colloidal mixers, for voids 20 liters and greater in volume.

603.19.12.5.5-Stand-by Equipment: During grouting operations, provide a stand-by grout mixer and pump.

603.19.12.6-Grouting:

603.19.12.6.1-General: Perform test to confirm the accuracy of the volume-measuring component of the vacuum grouting equipment each day before performing any vacuum grouting operation. Use either water or grout for testing using standard testing devices with volumes of 0.5 gal and 6.5 gal and an accuracy of equal to or less than 4 ounces. Perform one test with each device. The results must verify the accuracy of the void
volume-measuring component of the vacuum grouting equipment within 1% of the test device volume and must verify the accuracy of the grout volume component of the vacuum grouting equipment within 5% of the test device volume. Ensure the Engineer is present when any test is performed.

Grout tendons in accordance with the procedures set forth in the approved grouting operation plan. Grout all empty ducts.

603.19.12.6.2-Temperature Considerations: Maximum grout temperature must not exceed 90°F at the grout inlet. Use chilled water and/or pre-cooling of the bagged material to maintain mixed grout temperature below the maximum allowed temperature. Grouting operations are prohibited when the ambient temperature is below 40°F or is 40°F and falling.

603.19.12.6.3-Mixing and Pumping: Mix the grout with a metered amount of water. The materials will be mixed to produce a homogeneous grout. Continuously agitate the grout until grouting is complete.

603.19.12.6.4-Grout Production Test: During grouting operations the fluidity of the grout must be strictly maintained within the limits established by the grout manufacturer. A target fluidity rate will be established by the manufacturer’s representative, based on ambient weather conditions. The manufacturer’s representative shall be on-site at all times during this testing. Determine grout fluidity by use of either test method found in Section 603.19.4. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious ratio. Do not use grout which tests outside the allowable flow rates.

Prior to grouting empty ducts, condition the grout materials as required to limit the grout temperature at the inlet end of the grout hose to 90°F. Prior to performing repair grouting operations, condition the grout materials to limit the grout temperature at the inlet end of the grout hose to 85°F. Check the temperature of the grout at the inlet end of the grout hose hourly.

At the beginning of each day’s grouting operation, perform a Shupack Pressure Bleed Test in accordance with Section 603.19.4. If zero bleed is not achieved at the end of the required time period, do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.

603.19.12.6.5-Grout Operations: Open all grout outlets before starting the grouting operation. Grout tendons in accordance with the Grouting Operations Plan.

Unless approved otherwise by the Engineer, pump grout at a rate of 16 feet to 50 feet of duct per minute. Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at the grout inlet. Do not exceed the maximum pumping pressure of 145 psi at the grout inlet.

Use grout pumping methods which will ensure complete filling of the ducts and complete encasement of the steel. Grout must flow from the first and subsequent outlets until any residual water or entrapped air has been removed prior to closing the outlet.

Pump grout through the duct and continuously discharge it at the anchorage and grout cap outlets until all free water and air are discharged and the consistency of the grout is
equivalent to that of the grout being pumped into the inlet. Close the anchorage outlet and
discharge a minimum of 2 gallons of grout from the grout cap outlet into a clean receptacle.
Close the grout cap outlet.

For each tendon, immediately after uncontaminated uniform discharge begins, perform
a fluidity test using the flow cone on the grout discharged from all grout outlets. Discharge
a minimum of one gallon of grout for the fluidity test. The measured grout efflux time will
not be less than the efflux time measured at the pump or minimum acceptable efflux time
as established in Section 603.19.4. Perform fluidity test for each tendon to be grouted and
maintain the correct water to cement ratio. Alternately, check the grout fluidity using the
Wet Density method contained in Section 603.19.4. The measured density must fall within
the values established in Section 603.19.4. The density at the final outlet must not be less
than the grout density at the inlet. If the grout fluidity is not acceptable, discharge
additional grout from the anchorage outlet and test the grout fluidity.

Continue this cycle until an acceptable grout fluidity is achieved. Discard grout used
for testing fluidity. After all outlets have been bled and sealed, elevate the grout pressure
to 75 psi, seal the inlet valve and wait two minutes to determine if any leaks exist. If leaks
are present, fix the leaks using methods approved by the Engineer. Repeat the above stated
process until no leaks are present. If no leaks are present, bleed the pressure to 5 psi and
wait a minimum of ten minutes for any entrapped air to flow to the high points. After the
minimum ten minute period has expired, increase the pressure as needed and discharge
grout at each high point outlet to eliminate any entrapped air or water. Complete the
process by locking a pressure of 30 psi into the tendon.

If the actual grouting pressure exceeds the maximum allowed, the inlet will be closed
and the grout will be pumped at the next outlet, which has just been, or is ready to be closed
as long as a one-way flow is maintained. Grout will not be pumped into a succeeding outlet
from which grout has not yet flowed. If this procedure is used, the outlet/inlet, which is to
be used for pumping will be fitted with a positive shut-off and pressure gage.

When complete grouting of the tendon cannot be achieved by the steps stated herein,
stop the grouting operation. After waiting 48 hours, fill the tendon with grout in accordance
with the procedure outlined in 603.19.12.6.8.

603.19.12.6.6-Construction Traffic and Operations Causing Vibrations: During
grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from
all sources of construction activities such as moving construction vehicles, jackhammers,
compressors, generators, pile driving operations, soil compaction, etc., that are operating
within 300 feet down-station and 300 feet up-station of the ends of the span in which
grouting is taking place.

603.19.12.6.7-Post-Grouting Operations and Inspection: Do not remove or open
inlets and outlets until the grout has cured for 24 to 48 hours. Perform inspections within
one hour after the removal of the inlet/outlet. After the grout has cured, remove all outlets
located at anchorages and high points along the tendon to facilitate inspection. Inspect all
high points along the tendon as well as the inlets or outlets located at the anchorages.
Depending on the geometry of the grout inlets, drilling may be required to penetrate to the
inner surface of the trumpet or duct. Use drilling equipment that will automatically shut-
off when steel is encountered. Unless grout caps are determined to have voids by sounding,
do not drill into the cap. Perform inspections in the presence of the Engineer using endoscopes or probes. Within four hours of completion of the inspections, fill all duct and anchorage voids using the volumetric measuring vacuum grouting process.

Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes as specified in Section 603.19.13.2. Remove the inlet/outlet to a minimum depth of 2 inches. Use an injection tube to extend to the bottom of the drilled holes for backfilling with epoxy.

Post grouting inspection of tendons having a length of less than 150 feet may utilize the following statistical frequency for inspection:

1. For the first 20 tendons, inspect all outlets located at anchors and tendon high points by drilling and probing with an endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), continue testing all tendons until 20 consecutive tendons have been inspected and no voids have been found.

2. When no defects are detected as defined in No. 1 above, the frequency of inspection can be reduced to inspect every other tendon (50%). If a defect is located, inspect the last five tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

If tendon grouting operations were prematurely terminated prior to completely filling the tendon, drill into the duct and explore the voided areas with an endoscope. Probing is not allowed. Determine the location and extent of all voided areas. Install grout inlets as needed and fill the voids using volumetric measuring vacuum grouting equipment.

603.19.12.6.8-Vacuum Grouting: If vacuum grouting is required to repair voids in ducts, the following procedure shall be used:

1. Pressurize void and check for leaks
2. Seal leaks by a method approved by the Engineer
3. Measure the volume of the void to determine the necessary amount of grout
4. Mix sufficient amount of grout for use and for testing, record quantity of mixed grout
5. Test the grout using the flow-cone or the modified flow-cone method in accordance with Subsection 603.19.4
6. Evacuate air from the voids
7. Switch valve and inject grout into voids under pressure
8. Record quantity of grout remaining and calculate the amount injected
9. Seal all grout injection inlets
10. Clean equipment, area of operations on structure and properly discard unused grout
11. Record and report all vacuum grouting operations

603.19.12.6.9-Grouting Report: Provide a grouting report signed by the Contractor and/or the Subcontractor within 72 hours of each grouting operation for review by the Engineer.

Report the theoretical quantity of grout anticipated as compared to the actual quantity of grout used to fill the duct. Notify the Engineer immediately of shortages or overages.
Information to be noted in the records must include but not necessarily be limited to the following: identification of the tendon; date grouted; number of days from tendon installation to grouting; type of grout; injection end and applied grouting pressure, ratio of actual to theoretical grout quantity; summary of any problems encountered and corrective action taken.

603.19.13-Forming and Repairs of Holes and Block-Outs:
603.19.13.1-Repair of Holes and Block-Outs: Repair all holes and block-outs by filling with a non-shrink epoxy grout used to protect the post-tensioning anchorages. This non-shrink epoxy grout may be Embeco, Chem-Comp, Five Star or approved equal.

603.19.13.2-Repair of Grout Inlets and Outlets: Place threaded plastic caps in all intermediate grout inlet and outlet pipes and threaded plastic plugs to be installed at anchorages and grout caps shown on the Shop Drawings. Repair all intermediate grout inlets and outlet pipes shown on the Shop Drawings using a non-shrink epoxy grout (fluid or gel type) approved by the Engineer. Prepare the surface to receive the non-shrink epoxy grout in strict compliance with the manufacturer’s recommendations.

603.19.14-Protection of Post-Tensioning Anchorages: Within seven days upon completion of the grouting, protect the anchorage of post-tensioning bars and strands as indicated here. Clean all exposed surfaces of laitance, grease, curing compounds, surface treatments, misplaced mortar, grout, coating and oils by grit blasting or water blasting. After cleaning of all surfaces and acceptance by the Engineer, place a heavy unbroken coating of an epoxy bonding compound to all such surfaces. The epoxy bonding compound shall conform to AASHTO M 235, Type III.

Immediately upon the completion of the epoxy bonding compound application, install tight fitting forms securely against the previously placed concrete. Mix and place and fill forms with non-shrink epoxy grout in accordance with the manufacturer’s current standard technical guidelines. The non-shrink epoxy grout shall be placed within the “tack time” period of the epoxy bonding compound. Construct all pour-backs in leak proof forms creating neat lines. The non-shrink epoxy grout may require pumping for proper installation. Construct forms to maintain a liquid head to insure intimate contact with the concrete surface. Use vents as needed to provide for the escape of air to insure complete filling of the forms.

After anchorage material has properly cured in accordance with the manufacturer’s recommendations, the forms may be removed. After the pour-backs are a minimum of 28 days old, clean the surface of laitance, grease, curing compounds, surface treatments, oils and coatings, if any, by methods approved by the Engineer. Apply to all surfaces of pour-backs a coating in accordance with the Section 601.13 of the Supplemental Specifications.

603.19.15-Method of Measurement: The quantity of post-tensioning tendons to be paid for under this Section shall be the computed weight, in pounds (kilograms), of permanent post-tensioning steel tendons entered into the completed structure and accepted. Measurement shall be the theoretical plan length measured from anchor plate bearing face to anchor plate bearing face with no allowance made for waste or extension past the anchor plate faces. No
measurement will be made for temporary post-tensioning, which shall be considered incidental to the item "Post Tensioning Strands" and the item "Post Tensioning Bars".

For quantity determination the following unit weights shall be used:

<table>
<thead>
<tr>
<th>Prestressing System</th>
<th>Weight per Unit Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50 inch diameter seven wire strand</td>
<td>0.521 plf</td>
</tr>
<tr>
<td>0.60 inch diameter seven wire strand</td>
<td>0.740 plf</td>
</tr>
<tr>
<td>1 inch high strength deformed bar</td>
<td>3.010 plf</td>
</tr>
<tr>
<td>1-1/4 inch high strength deformed bar</td>
<td>4.395 plf</td>
</tr>
<tr>
<td>1-3/8 inch high strength deformed bar</td>
<td>5.564 plf</td>
</tr>
</tbody>
</table>

**603.19.16-Basis of Payment:** Post-tensioning tendons will be paid for at the contract unit price per pound of steel strand and per pound of steel bar, complete and in place. Payment shall be full compensation for furnishing, installing, stressing, grouting all post-tensioning tendons, and probing and inspecting grouted anchorages. Payment shall also include anchorage assemblies and post-tensioning system hardware which is not embedded in concrete, grout and grouting, all testing, anchorage protection systems, and all labor, materials, tools, equipment, and incidentals necessary for completing the work in accordance with these Special Provisions and the plans. This payment shall also include lubricant in the tendon ducts for friction control. No separate measurement and payment will be made for anchorage components, including anchorages and diablos for future tendons and spare ducts, local anchorage zone reinforcement supplied as an integral part of a proprietary anchorage system, nor ducts for similar post-tensioning system hardware. Anchorage components, ducts, and similar items of post-tensioning system hardware, which are embedded within the cast-in-place concrete, shall be deemed to be included in the cost of the cast-in-place concrete.

In the event that the Contractor constructs the structure with an accepted alternative not detailed on the Plans, the payment shall be based on the unit price bid extended by either the quantities shown on the Plans or the actual quantities used and accepted, whichever is less.

**603.19.17-Pay Items:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 603003-001</td>
<td>Post Tensioning Strands</td>
<td>per pound (kilogram)</td>
</tr>
<tr>
<td>Item 603004-001</td>
<td>Post Tensioning Bars</td>
<td>per pound (kilogram)</td>
</tr>
</tbody>
</table>
WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
SPECIAL PROVISION

FOR

STATE PROJECT NUMBER: ____________________________
FEDERAL PROJECT NUMBER: ____________________________

SECTION 604
PIPE CULVERTS

601.1-DESCRIPTION:

ADD THE FOLLOWING TO THE SECTION:

604.1.1-Cured-In-Place Pipe Liner: The purpose of this special provision is to describe the work and material required to line an existing pipe with a new cured-in-place (CIP) pipe liner.

604.2-MATERIALS:

ADD THE FOLLOWING TO THE SECTION:

604.2.5-Materials: The CIP pipe liner must be a continuous system (jointless) and must provide for complete structural integrity, independent of the load bearing capacity of the existing host pipe. The CIP pipe liner shall conform to ASTM D5813 and be designed according to ASTM F1216 as a fully deteriorated gravity pipe. Design the structural spray liner rehabilitation system to support the dead load and live load. Use the following AASHTO HL-93 live loads for calculations:

<table>
<thead>
<tr>
<th>Cover</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ft.</td>
<td>30.8 psi</td>
</tr>
<tr>
<td>2 ft.</td>
<td>13.4 psi</td>
</tr>
<tr>
<td>3 ft.</td>
<td>7.3 psi</td>
</tr>
<tr>
<td>4 ft</td>
<td>4.6 psi</td>
</tr>
<tr>
<td>5 ft</td>
<td>3.1 psi</td>
</tr>
<tr>
<td>6 ft</td>
<td>2.2 psi</td>
</tr>
<tr>
<td>7 ft</td>
<td>1.6 psi</td>
</tr>
<tr>
<td>8 ft</td>
<td>1.2 psi</td>
</tr>
<tr>
<td>9 ft&gt;</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Use the following minimum design parameters:
1. ground water level will be top of the existing pipe unless site conditions indicate a higher value
2. soil density of 120 pcf
3. soil modulus of reaction of 2000 psi
4. factor of safety of 2

604.6-LAYING AND JOINING:

ADD THE FOLLOWING TO THE SECTION:

604.6.4-Cured-In-Place Pipe Liner: Installation of the CIP pipe liner shall meet the following requirements.

   604.6.4.1-Installation: The Contractor shall provide a CIP pipe liner that is able to mold itself or fit tightly to the shape of the existing pipe. The CIP pipe liner must be capable of conforming to the pipeline bends in the existing pipe without splitting, rupturing, or wrinkling of the CIP pipe liner material. The CIP pipe liner must provide a flow capacity equal to, or greater than, that of the existing pipe prior to rehabilitation. Submit a written installation plan for the conduit renewal to the Engineer for acceptance at least ten days before beginning work. Provide design calculations performed and stamped by a Professional Engineer registered in West Virginia.

   Installation shall be per ASTM F1216, ASTM F1743, ASTM F2019 and per the manufacturer’s recommendations. All process water and condensate from steam used in the installation and curing process shall be managed per 107.21 through 107.24, inclusive, as a liquid waste.

   The work covered under this section includes furnishing all labor, materials and equipment required for installing a new CIP pipe liner system within an existing pipe. Minor work may be required to prepare the existing pipe for installation of the new CIP pipe liner and to complete the installation of the CIP pipe liner. Inspect the existing pipe using experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry before and after installation of the CIP pipe liner. Clean, remove debris, and repair conduit walls and joints prior to installing the CIP pipe liner. Restore active service connections after installation of the pipe liner.

604.14-PAY ITEMS:

ADD THE FOLLOWING TO THE TABLE:

<table>
<thead>
<tr>
<th>ITEM</th>
<th>DESCRIPTION</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>604125-*</td>
<td>“size”, Cured-In-Place Pipe Liner</td>
<td>Linear Foot (Meter)</td>
</tr>
</tbody>
</table>

“size” - Normal
* Sequence Number